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DESTRUCTION OF DEBRIS BARRIER NO. 1, YUBA RIVER, CALIFORNIA.

By E. C. MURPHY,* Assoc. M. Am. Soc. C. E.

During a flood of unprecedented magnitude on the Yuba River, in California, in March, 1907, Barrier No. 1, constructed under the direction of the California Debris Commission for the purpose of holding back the mining debris that is being swept down the river by floods, was destroyed. This structure was developed after much study, and after the failure of a brush and rock dam built by this Commission on this stream about a mile above the site of the barrier. Its failure is worthy of careful study.

This structure is described in detail in the reports of the Debris Commission, in Transactions of the American Society of Civil Engineers, Vol. 57, pp. 20-26, and briefly in Engineering News, Vol. 53, p. 609 (June 15, 1905).

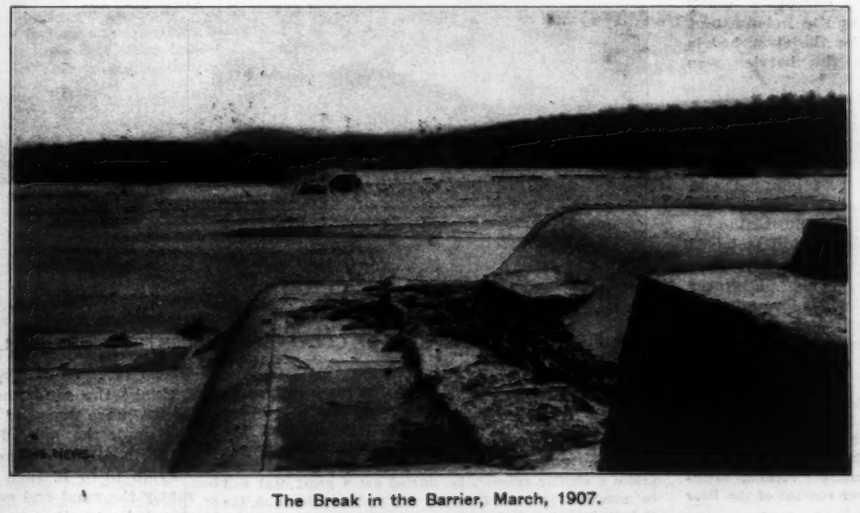
From 1849 to 1880 enormous quantities of debris—sand, gravel and cobbles, the tailings of hydraulic mining—were deposited in the upper courses of the streams that drain the west slope of the Sierra Nevada Mts. in California. The volume of this debris in the Yuba River has been variously estimated at from 71,000,000 to 700,000,000 cu. yds. At the mouth of this river, near Marysville, this deposit has a depth of 7½ ft.; at Duguerra Point, 11 miles above the mouth, it has a depth of 26 ft.; and at the Narrows, 18 miles above the mouth, it has a depth of 84 ft.

This barrier is located fourteen miles above the mouth of the Yuba, where the stream leaves the foothills. The details of its construction are shown by Fig. 3. It is a hydraulic-filled dam, anchored by piles, rock and a concrete facing, and consists of a series of steps 8 ft. in height (except the first, which is 6 ft.), each successive step added when necessary to prevent the gravel from passing over the structure. The hydraulic fill was accomplished by the stream itself.

The piling, which has a depth of penetration of at least 30 ft., does not support the weight of the concrete facing. This facing is made in blocks, held together by wire cables imbedded in the concrete, and rests on the gravel bed or the rock filling. This arrangement permits the concrete blocks to follow down any considerable scour under the apron. The apron is extended 6 ft. below the lower row of piles, so that in case of underscour this lip will break, fall into the hole, and stop or retard under-cutting. Sheet-piling was not used, on account of the difficulty of driving. Instead, 3-in. planks were spiked horizontally to the up-stream and down-stream rows of piles, and carried to such depths as water permitted.

The first step and apron were completed in the fall of 1904. During the following winter and spring the reservoir back of this step was filled with debris. In the fall of 1905 a second step was added and by July, 1906, the space behind this step was filled with debris. Instead of adding a third step in 1906, a spillway 65 ft. wide in the narrowest section, and having a sill 3 ft. below the crest of the barrier, was built. All the debris brought down by the high water of February and March, 1907, passed over the barrier. Its effect will be noted in another paragraph.

Effect of Scour on Apron; Summer of 1906.



The Break in the Barrier, March, 1907.

THE FAILURE OF DEBRIS BARRIER NO. 1, YUBA RIVER, CAL.

(Photographs taken by Dr. G. K. Gilbert.)

The barrier failed on the night of March 18, 1907, about three hours before the river reached its maximum stage. The depth of the water on the crest was 7.5 ft. at the south end and 6.5 ft. at the north end. The stream discharge at the time of failure is somewhat uncertain, but was at least 100,000 sec.-ft. For two weeks prior to the failure the river stage was about normal, the depth on the south end of the crest varying from 2.5 to 3.5 ft. On March 17 it rose to 6.2 ft., and on the night of March 18, to upward of 7.5 ft. On Feb. 2, 1907, the depth was 5.5 ft. The greatest depth of water on the barrier prior to Feb. 2, 1907, was 5.3 ft. at the south end on Jan. 18, 1906. The Yuba River on the night of March 18 reached a stage at least 1 ft. above previous records, and the Feather River was at least 4 ft. higher than the highest flood marks of 1861.

Some 630 ft. of the barrier (see Fig. 2) extending from 80 ft. from the south abutment to 540 ft. from the north abutment was completely

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swept away; 70 ft. or more of the north part remaining is undermined and badly damaged, and all except 120 ft. of the apron on the north side was swept away. The concrete surface is badly worn by the debris. The top of the lower step has holes through it. These holes are at the joints, between two slabs. At the foot of the rollerway, where it joins the step below, the pebbles are knocked out of the concrete, but near the lower end of the step, where the action of the debris was grinding more than pounding, the pebbles of the concrete are half or more than half worn away, showing a strong adhesion of the cement to the pebbles.

The failure was probably due to undermining, caused by the backlash; the latter having been aided by weakening of the concrete surface by the scour of the debris.

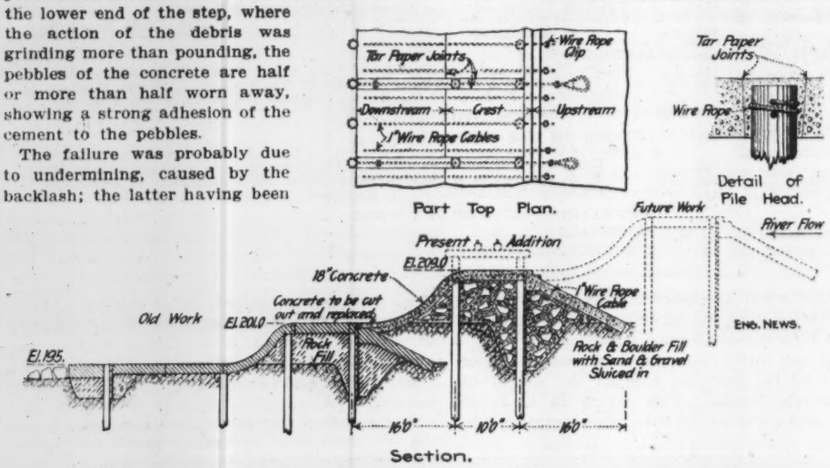


FIG. 3. DETAILS OF DEBRIS BARRIER NO. 1, YUBA RIVER, CAL.
(Reproduced from Engineering News, June 15, 1905.)

The high water each season since the barrier was constructed has scoured a hole in the apron (see Fig. 2), despite the fill of large rock the previous season. In 1905, when the second step was added, 5,700 tons of large rock were used for this fill. Two floods larger than the barrier had previously withstood, following each other with no opportunity between them for repairing the scour at the toe, must have undermined the structure.

It is also evident that as the concrete of the part of the barrier which remains has holes worn through it the part that was swept away must have had holes worn through it also, as the depth of water and quantity of debris passing over the latter was greater than over the former. It is quite likely that either of these actions—undermining and wear of concrete—would alone have caused failure in this flood.

All the debris held back by the barrier has passed below the structure, except a small amount immediately above it and in indentations in the banks. Below the barrier the river bed is somewhat higher than when the barrier was built.

[In response to an inquiry as to the probable future of the barrier in question, the author of the foregoing article states that apparently no more work along this line will be attempted, and that instead the energies of the Commission will be devoted, if the necessary authorization is given, to dredging work. This opinion is based on the following summary of a report submitted to Brig.-Gen. A. Mackenzie, Chief Engineer U. S. Army, by the California Debris Commission. The report was made last April and was signed by Col. W. H. Heuer, Maj. C. H. McKinstry and Maj. Wm. W. Harts. The summary was as follows:

Conclusions: To summarize, therefore, the Commission is of the opinion.

(1) That it is advisable to attempt to divert the Bear or American Rivers into the tule lands.

(2) That it is inadvisable to construct settling basins and restraining barriers in the lower courses of the Bear and American Rivers.

(3) That it is now time to commence the work of restoring the navigable conditions of 1880 in the Sacramento and Feather Rivers.

(4) That the most feasible and advantageous method of accomplishing this is by dredging.

In pursuance with these conclusions, and in compliance with the requirements of the act of March 1, 1893, the commission recommends as follows:

(1) That an appropriation of $400,000 be made by Congress, contingent upon a similar appropriation being made by the State of California, part of this sum to be devoted to the construction of two hydraulic dredges of high power, and the remainder to their operation and maintenance, in accordance with the general terms of this report, for improving the navigability of the Sacramento and Feather Rivers, and for disposing of the mining debris brought into them by their tributaries.

(2) That these funds be expended by the California Debris Commission under the direction of the Secretary of War, all rights of way and easements for levees and spill banks to be furnished free of cost to the United States.

The River Improvement and Drainage Association of California, which organization has been working for the betterment and improvement of the conditions of the rivers of California, has brought about a harmonizing of the interests of the various industries involved in the question of hydraulic mining, and the miners, farmers and navigators are united in a common cause. The Sacramento Drainage Commission, the members of which were elected by the land owners whose lands are involved in the problem, has been studying the situation and has furnished much data relating to conditions. This commission was provided for in the bill passed at the 1905 session of the State Legislature, as introduced and fostered by the River Improvement and Drainage Association to carry out the provisions of the Dabney Commission of Engineers, which was also appointed by the State at the instance of the River Improvement and Drainage Association.

It is now time to commence the work of restoring the navigable conditions of 1880 in the Sacramento and Feather Rivers. This is the point that has been brought forward strongly by the River Improvement and Drainage Association, and if the recommendations of the commission that Congress appropriate $400,000 to be expended on California rivers, providing California appropriate a similar amount, be carried out a great deal will be made in the way of solving the problem, for with the United States and the State of California committed to channel rectification the land owners will awaken to the necessity of working on a comprehensive plan to reclaim their land.

These conclusions are of great interest, in so far as they indicate the abandonment of the interesting plan of natural hydraulic fill dam construction.—Ed.]

THE LOCUST POINT PIER COLLAPSE IN BALTIMORE.

At the time that Pier 8 at Locust Point, Baltimore, collapsed, on April 27 of this year, we published but a brief news note concerning the accident (Eng. News, May 2, 1907). At that time even the engineers and officials most intimately connected with the work were in the dark as to the true cause of the accident.

Information from a reliable source now enables us to give our readers the probable cause of the collapse. We also reproduce two photographs of the wrecked pier. Of these, Fig. 1, taken from the water side, shows the entire settled portion, and, at the shore end, the amount of settlement in the break between the uncovered framework and the roofed-over settled part.

Fig. 2 shows, in the lower right-hand corner, where the concrete work on the timber deck mentioned later broke and settled.

The pier was founded on piles, with from four to six rows of batter piles around the outside. The piles were cut off one foot below mean low water, and a deck of 12-in. Georgia pine laid thereon. The total number of piles driven was over 10,000; they were driven in transverse rows with about four feet between the rows.

On the outer edges of the deck were built concrete retaining walls, about 10 ft. in height, and two other concrete walls, one on either side of the longitudinal center line, enclosing a way for two standard-gage railway tracks.

Concrete piers built on the deck supported the columns of the superstructure. Between these piers, 10 ft. in height, sand was filled in and the planking of the first floor laid upon it.

The piles averaged 60 ft. in length. They were driven firmly against gravel, and when some were pulled up they showed gravel embedded in the wood at the bottom ends. The bottoms of the piles, when driven home, averaged about 25 ft. below the bottom of the river, 10 ft being through soft mud, the remainder through clay and sand in the main.

The load on each pile averaged about eight tons. On no individual pile was the load as much as 15 tons, and they were calculated to bear 24 tons each.

It was considered advisable, by the engineers in charge of the work, to stiffen up the layer of silt and soft mud at the immediate bottom of the river, so as to shorten the column length of the piles and give additional lateral stability. For this purpose sand and gravel were dumped around and among the piles through openings in the decking; the sand and gravel, dumped in 2-ft. layers, were expected to mingle with and stiffen the mud, the mud displaced being expected to move in all directions.

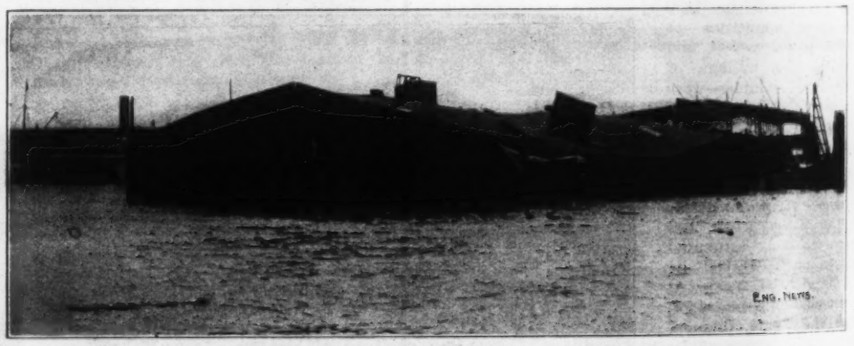


FIG. 1. GENERAL VIEW OF COLLAPSED SUPERSTRUCTURE OF LOCUST POINT PIER. BALTIMORE, MD.

From 10 to 12 such layers were placed. Apparently the sand and gravel sank into the mud and mingled with it only a sufficient distance to stiffen the upper layer of it enough to carry temporarily the weight of the other sand and gravel being added.

On or about April 17, slight lateral movement was observed at the outer end of the pier. In order to overcome a tendency of the structure to move laterally toward the east all of the sand

and gravel available were dumped on that side, but this proved inadequate as a preventive.

Although a transitman had been detailed to watch the pier for lateral movement, he gave warning of the collapse only ten minutes before it occurred. Apparently, the softer stratum of mud underneath the stiffened and gravel-weighted layer on top, was squeezed out from under the latter as an orange seed is propelled from between one's fingers; this caused the weight of the sand and gravel fill to move in the same direction, and in moving it carried the piles over.

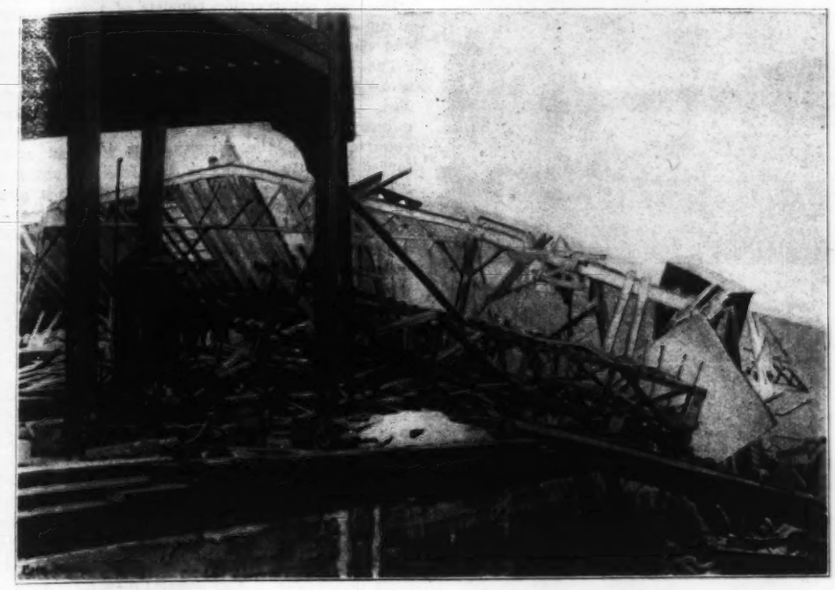


FIG. 2. COLLAPSE OF B. & O. PIER AT LOCUST POINT, BALTIMORE; SHOWING CONCRETE RETAINING WALL BROKEN.

There were about 5,000 piles in the collapsed portion of the shed. Their movement was entirely lateral, no sinking whatever occurring.

PRIMING COATS FOR METAL SURFACES: LINSEED OIL VS. PAINT.*

By F. P. CHEESMAN,† M. Am. Soc. T. M.

Previous to 1885 it was almost a universal custom to use boiled linseed oil as a shop or priming coat for metal. At the present time very few bridge engineers specify the use of boiled oil. Yet there are enough still doing so to make it worth the effort to call their attention to the fact that they are making a mistake and inviting corrosion by so specifying.

I will not attempt to go into the chemistry of linseed oil, the fact being that we know less about linseed oil than probably any other oil used in the manufacturing trade. This is due largely to the fact that we cannot get a recognized standard for linseed oil, owing to the great changes which take place in the article itself. The yield of oil from year to year varies from 22% to 34% from North American seeds, while it has been known to go as high as 40% in foreign seeds; the percentage of water ranges from 6% to 10½%. For the paint trade the quality of the oil is measured by its power of absorbing oxygen, and, rated by that standard, Baltic seed is No. 1; Bombay, Calcutta and Black Sea seed No. 2; North American seeds No. 3 [although there is quite a difference in the values of North American seeds, Dakota seed making better oil than Missouri seed, and seed from new soil better oil than from old soil on which fertilizers have been used], and Argentine seed No 4, or poorest. The quality of the seed does not seem to depend upon climatic conditions so much as upon the quality of the soil.

At a meeting in 1906 of the New York Section of the Society of Chemical Industry, Dr. A. H. Sabin in an article on "The Oxidation of Linseed Oil," showed that after the same oil had been placed in six glass flasks connected together with tubing and allowed to stand in a well lighted room there was such a difference in the weight after drying that one had gained two and one-half times as much as the other, the respective figures being 10.1% and 25.5% gain. Dr. P. C. McIlhiney at the same meeting said, with regard to the atmospheric oxidation of linseed oil, he had himself found that the same sample of linseed oil would at different times, and under conditions that were apparently the same, absorb very different percentages of oxygen, or at least that the increase of weight on drying was very different. I mention the above to show why it is possible to have conflicting results when the paintmaker has made no change in his vehicle. Linseed oil is to-day the best paint vehicle we know of, but it contains some of the still unknown mysteries of nature and it occasionally gives us a knockout blow.

Several very interesting facts were stated by practical men at the third annual convention of the Maintenance-Of-Way Master Painters' Association of the United States and Canada, held in New York, November 13 and 14, 1906, and are printed in their proceedings. Mr. J. W. Houser (Cumberland Valley R. R.), President of the Master Car and Locomotive Painters' Association, stated the following experiences:

We have another bridge crossing the Potomac River; I do not recall just when that was painted—perhaps in 1892. That came to us with a coating of boiled oil and we have had quite a good deal of trouble with it. I do not like to see a coating of boiled oil on a bridge; I would rather have it a little rusty than with this shop coating of boiled oil. I believe we can take care of rust before the bridge is painted better than we can after it has this shop coating; it seems to hold the blue scale for a little while, but will finally give way. We had the same trouble on a bridge at Martinsburg, although we tried to clean it the best we could. I think if the shop coat of boiled oil had been left off we would have had no trouble. I do not know what experience you have had, but this has been mine—on new work of course. Old work we have to take care of as everybody else does; we scrape it where necessary, and as a rule give two coats of paint. But I would like to know if the experience of others with boiled oil has been the same as mine.

Mr. H. J. Barkley (Ill. Central R. R.) said:

We have had the same experience. We had 50 sets of plate-girders come to us with a shop coating of boiled oil (I suppose it was given so as not to cover up the shop marks), and we had similar experience with them; a wire brush had no effect on the oil. They have been in use for five or six years, and are in a terrible shape. We could not get off the blue scale and rust when they were first painted.

Mr. J. H. Cummin (Long Island R. R.) said that he did not think we can lay that to the manufacturers of steel work. The engineers specify how the steel is to come from the works; some specify a coat of boiled oil, some a coat of red lead. So you want to get back at the engineers, not the manufacturers. The writer in the course of his remarks made the following statements:

Any practical master painter will allow that boiled linseed oil when used alone for the first coat on metal will not dry hard in weeks. It oxidizes on the surface, absorbing moisture and forming a skin, leaving the underneath portion soft and easily knocked off in shipping, and later on will cause subsequent coats of paint to crack and peel. This is because the first coat of oil must dry some time, and in doing so will force the top coats to crack, and sooner or later come off.

Mr. Emil Gerber, M. Am. C. E., in his report on the Illinois Central R. R. bridge at Cairo, Ill., shows that the approaches, which received one shop coat of paint, weathered better than the bridge, which received one shop coat of oil. When the Cumberland Valley R. R. bridge at Harrisburg, Pa., was built, in 1887, it was built jointly by the Edge Moor and the Union Bridge Works, and one applied a shop coat of paint and the other a shop coat of oil. After erection it was found that the oiled part of it was rusting very badly. Two coats of our paint were soon applied on the entire structure and the section that received one coat of paint at the shop stood much the better.

Mr. R. I. Sloan, late chief engineer of the South Side Elevated Railroad, Chicago, Ill., specified oil for the priming coat. He allowed the Lassig Bridge and Iron Works to paint the section that they built at their shops with one coat of oxide-of-iron paint, and the structure received two coats of our light colored paints. The section built by Lassig, covered with three coats of paint, weathered much the better.

We also quote from Mr. M. B. Wood's book on "Rustless Coatings":

Many engineers advocate the use of boiled oil alone for the first or priming coat, applied either at the rolling-mill to protect the metal during its transit from the mill to the construction shop, or at the shop when ready to ship for erection. The general reason assigned for this practice is that the boiled oil "soaks into the scale and dries and prevents further tendency toward corrosion."

This theory is absolutely without proof, from any standpoint How far any oil or liquid can soak into iron or steel or the still harder mill-scale that forms on these metals, these Solons do not state. The use of such oil coatings is, in general, to conceal some slop-work on the part of the inspector, or constructor, at an earlier stage of the work than would be possible later on. However consistent and beneficial the first coating of oil may be for a wood or masonry surface, it has no place on a metallic one, when applied for the correction of the mill-scale evil. No number of these oil or even paint coatings will soak into and bond these scales together, or to the metal surface. There are hundreds of records of the painting of important railway structures, where the "first coat of boiled-oil" method was used, and, in the great majority of instances, the utter and rapid failure of the coating, and the extra corrosion of the structure, could be directly assigned to this so-called method of protection. The weather resisting power of an oil coating is almost nil compared with that of a paint. If the advocates of oil coatings are so sure of its benefits as against a paint, why not make all the coatings of oil alone, no matter what it covers, a wire or an anchor? It will soak as far into one as the other. A paint coating can be applied as quickly and easily to any surface as an oil coat; will dry as quickly and as hard, and is in every way a better resistant to atmospheric or mechanical injuries.

A foundation coat of oil is a direct cause of the blistering and peeling of the coatings spread over it. It is seldom dried enough before the other paints are spread over it, to ensure a close adherence to the metal it covers. When the subsequent coats of paint are spread, the solvents and oils in them soften to some extent the underlying coat of oil, and a moderate heat from the sun causes the whole coating to blister or peel. Too much oil in a paint coating, particularly if the surplus oil is in or near the foundation coat, whether on a wooden or metallic surface, will generally cause peeling regardless of the pigment used in the coatings.

In 1904 I examined with Mr. Byrnes, the engineer in charge, the Newtown Creek Bridge, New York City, a new structure then being erected, and on which had been applied a shop coat of boiled linseed oil, and we found the steel underneath very badly corroded, and he stated then that it would be the last time that he would ever allow the use of boiled linseed oil if he had anything to say about it.

A few months ago I had an occasion to examine one of the new piers being erected in New York City with the engineer and found the same trouble there—corrosion under a coating of boiled linseed oil and he was convinced that to specify linseed oil for a priming coat leads to poor results.

I might go on and cite many other cases, but I think that I have taken up enough time and produced enough evidence to show that linseed oil by itself is a bad thing The question now arises—what pigment would you recommend using in connection with linseed oil for a priming coat? and to this I answer that the paint doctor must be advised upon several points before he can prescribe the proper pigment. Will the metal be painted under cover, and how much time will be allowed for drying? If it is a rush job, we want to use a pigment that will not retard the drying of the oil, as, for instance, carbon black is a very durable pigment, but it does not want to be used on a rush job. Is the material to be shipped a long distance? and what kind of exposure will it have before its second coat? Will the metal be properly cleaned before the shop coat is applied? All of these questions must be answered before we can state intelligently what is the best pigment to use. Where no information can be obtained, as a general rule it is safe to use a selected high-grade natural ore iron oxide paint, while for many locations a blue lead paint would be best and in others a combination of red lead and graphite, or a carbon black paint.

A MINIATURE HEAD-TELEPHONE has been developed in Sweden, according to a report by the U. S. Consul at Gothenburg. The receiver is said to measure ½-in. by ⅝-in., and over the diaphragm may be screwed a cover continued into an ear-tip. The connection to the receiver may be a fine flexible cord carried like an eyeglass cord. No helmet or other attaching device is required to hold the receiver in place. The instrument is thought to be valuable both to telephone operators and to individuals with defective hearing, the latter also carrying a transmitter, etc., on the person. The device was invented by the chief of the government telephone department.

*Slightly condensed from a paper read before the American Society for Testing Materials at Atlantic City, N. J., June 21, 1907.

†National Paint Works, 92 William St., New York City.

NEW WATER PURIFICATION PLANT AT EXETER, N. H.

By ROBERT SPURR WESTON,* Assoc. M. Am. Soc. C. E.

Since 1887 the Town of Exeter, N. H., has been supplied with water pumped for the most part from an impounding reservoir on Wheelwright's Brook. For a short period the supply was obtained from a well, but the yield from this source has been supplemented with water from the reservoir.

The population of Exeter increased from 4,284 in 1890 to about 5,320 in 1906. The average daily consumption of water is about 350,000 gals.; the maximum, 600,000 gals.

RESERVOIR.—The reservoir (Fig. 1) has an area of 19 acres. The banks are quite steep and are covered with turf. There are several small sloughs entering the reservoir, and the shores of the pond show layers of clay which, when washed by the waves, render the water quite turbid. The color of the water is quite high, but there are few if any sources of pollution on the drainage area. Fresh water snails and clams abound and have been pumped into the distribution system at times past.

Nitrogen as total albuminoid ammonia	0.119
Nitrogen as free ammonia	0.003
Nitrogen as nitrites	0.003
Nitrogen as nitrates	0.06
Chlorine	4.95
Hardness	32.
Alkalinity	24.
Total residue on evaporation	75.

The analysis of this water shows that it contains too much organic matter, too much turbidity and too much color to be used as a satisfactory source of supply at all times of the year without purification.

Fig. 1. View of Impounding Reservoir, Water-Works of Exeter, N. H.

OLD FILTERS.—Previous to 1906 part of the supply was filtered through three pressure mechanical filters, practically without coagulant.

The writer made a report in January, 19[illegible] advising the installation of a coagulating bas[illegible] and two mechanical filters having a total capa[illegible] of 600,000 gals. per diem, and using sulph[illegible] of alumina as a coagulant. Later the size [illegible] this plant was increased to a capacity of 1,[illegible]000 gals. per diem, to correspond with the ca[illegible]ity of the present pumps.

GENERAL DESCRIPTION OF NEW PL[illegible]NT.

The new construction consists of a coagu[illegible]ing basin and filters, placed between the res[illegible]oir and the pumping station.

The coagulating basin and filters occu[illegible] a space 45 × 47 ft., immediately below the res[illegible]oir dam. With the exception of the roof, the trimmings of the filter house, the piping and the filter appurtenances, the structure is built of reinforced concrete.

To describe the plant in general terms it may be said that a concrete coagulating basin, covered with an arched roof, adjoins two filters and a pipe gallery (see Fig. 2). The filters are covered partly by a flat roof, partly by a filter house, which latter also extends over the roof of the coagulating basin to form a room for the storage

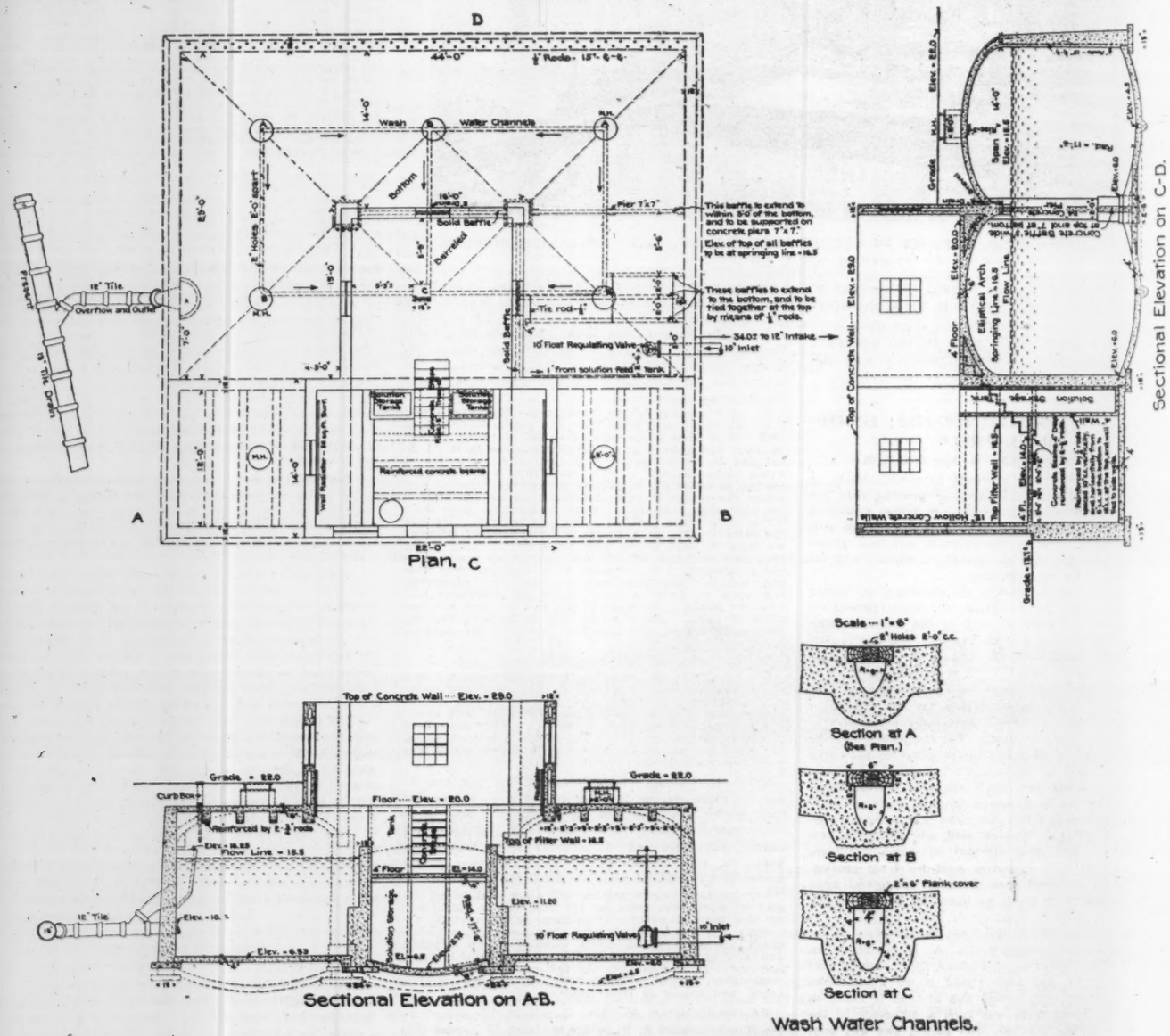


FIG. 2. COAGULATING BASIN AND MECHANICAL FILTERS, EXETER WATER-WORKS.

The average analysis of the reservoir water is as follows:

	Parts per million.
Odor	2. Vegetable.
Turbidity	Decided.
Color	47.

*Consulting Engineer, 14 Beacon St., Boston, Mass.

and application of sulphate of alumina, which is used as a coagulant. Part of the structure is in excavation; part is in an embankment, with 1 on 1.5 slopes; while the filter house proper is exposed.

COAGULATING BASIN.—The coagulating

basin (Fig. 2) is 44 ft. long by 29 ft. wide inside and has a storage capacity equivalent to about two hours' flow, when the filters are operated at the rate of 1,000,000 gals. per diem. Under present conditions this period of coagulation is nearly twice as great. A gutter is formed in the floor of the coagulating basin. It is covered with 2-in. plank, in which holes are bored, 2 ft. c. to c. This gutter cover is for use when cleaning the basin and was designed to distribute the water used for washing out the basin along the whole length of the gutter.

A concrete overflow formed in the wall connects with a previously existing drain leading from the reservoir to the spillway. A 6-in. pipe also connects with this drain and serves to draw the contents of the coagulating basin to a point 5 ft. above the bottom of the same, below which point the contents must be lifted out by means of an ejector. This is because the bottom of the basin is lower than the reservoir spillway.

The 6-in. sluice gate on the basin-drain, as well as the 6-in. valve and ejector, are all operated from outside the basin. The usual manholes are provided for entrance and hose connections are placed within the basin.

The reservoir water flows into the basin by gravity, through the 10-in. inlet pipe and float valve. Sulphate of alumina is added at the inlet, mixture being assisted by one horizontal and three vertical baffles, placed near the inlet. Partitions between the piers control the passage of water from inlet to outlet. The pipe and elbow outlet is located about 3 ft. below the flow line of the basin, in the wall between basin and filters, and connects directly with the latter by means of a 10-in. pipe and connections.

FILTERS.—The filters, two in number, are each 12x15 ft. in plan. They are built of concrete, with flat slab roofs, supported by reinforced concrete beams. The filter house projects over parts of the filters, thereby permitting the attendant to observe their operation. A manhole is placed in the roof above each filter, to be used for placing the filtering materials.

PIPE GALLERY.—The pipe gallery (Fig. 3) lies between the front walls of the two filters. It contains most of the piping, the wash water ejector, and the valves, except the waste water valve, which latter, a 12-in. sluice gate, is placed upon the inner face of the filter wall. The floor of the pipe gallery is below the level of the spillway and is drained by a 1-in. steam ejector.

REGULATING DEVICE.—The device for regulating the flow of water through the filter is simple and not automatic. It consists of a constriction in the effluent pipe and a manometer. The differences in pressure where the water flows through this constriction are shown in a glass U-tube, which connects with the effluent pipe by means of two pressure tubes. The scale alongside the U-tube was graduated by experiment and the operator manipulates the effluent valve so as to maintain an approximately constant difference in water level between the two arms of the tube. For low rates a greater difference in level might be obtained by inserting a flat brass ring between the flanges of the effluent pipe where the diameter is smallest, the hole in the ring to be smaller than the smallest diameter of the pipe.

OPERATING PLATFORM.—A concrete floor was constructed over the pipe gallery. On this floor are the sampling devices, the U-tubes, the head gages, the hand wheels of all the valves, and a gage showing the height of water in the reservoir. Steps lead from this floor to the coagulant room, and entrance is through a door with a sill slightly above the natural ground level.

SAMPLING AND INSPECTION APPARATUS.—A wash bowl and stand is placed in front of each filter, as shown in detail by Fig. 4. A small pump discharging into the bowl can be used to lift samples of water from the effluent pipe. The washing of the filter may be observed from the platform. There is a gage board showing the level of water on the filter and a float gage showing that in the effluent pipe. The difference in readings is the loss of head. Ordinarily the water level on the filter is constant.

STRAINER SYSTEM.—The strainer system is similar to that in the filters at Paris, Ky.* On the bottom of each filter tank is a 1-ft. layer of concrete. In this channels are formed: a main channel running the length of the filter and 19 pairs of lateral channels, 9½ ins. c. to c. The main channel is uniform throughout its length, while the lateral channels diminish in area of cross section from center to sides of the filter. These channels are covered with slabs, into

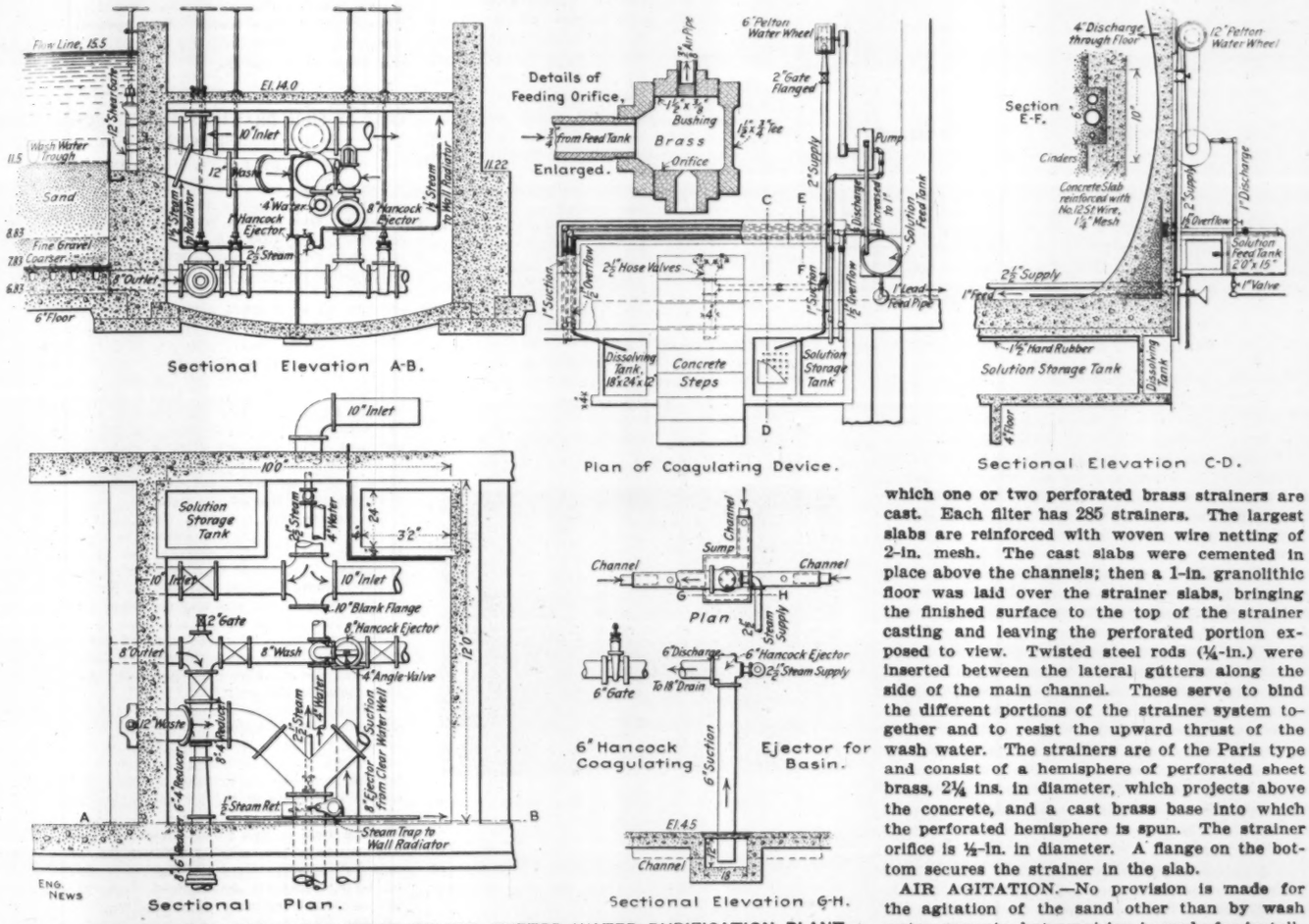


FIG. 3. PIPE GALLERY AND COAGULATING DEVICE, EXETER WATER PURIFICATION PLANT.

which one or two perforated brass strainers are cast. Each filter has 285 strainers. The largest slabs are reinforced with woven wire netting of 2-in. mesh. The cast slabs were cemented in place above the channels; then a 1-in. granolithic floor was laid over the strainer slabs, bringing the finished surface to the top of the strainer casting and leaving the perforated portion exposed to view. Twisted steel rods (¼-in.) were inserted between the lateral gutters along the side of the main channel. These serve to bind the different portions of the strainer system together and to resist the upward thrust of the wash water. The strainers are of the Paris type and consist of a hemisphere of perforated sheet brass, 2¼ ins. in diameter, which projects above the concrete, and a cast brass base into which the perforated hemisphere is spun. The strainer orifice is ½-in. in diameter. A flange on the bottom secures the strainer in the slab.

AIR AGITATION.—No provision is made for the agitation of the sand other than by wash water currents, but provision is made for installing a system of air pipes, should it be judged desirable in the future. To this end paraffin candles were set in the concrete floor. Should the air system become necessary the paraffin could be removed and the holes used to take the standards for the support of the air pipes.

OVERFLOW CHANNELS AND WASH WATER TROUGHS.—The overflow channel, one for each filter, is formed in the front wall of the filter with the aid of a steel plate running from side to side. It is 14x12 ins. in cross section. To each of these plates two sheet steel overflow troughs are riveted, which have a circular bottom and are 8 ins. wide by 10 ins. deep (see Fig. 5). Each trough is supported at its outer end by three rods, which have turn-buckles for the leveling and adjustment of the trough. The waste pipe takes the water away from the overflow channel, while the inlet pipe enters it.

GRAVEL.—Above the strainers there is an 8-in. layer of coarse gravel of a size passing 1-in.

*Engineering News, May 3, 1906.

and retained on a ¼-in. sq. mesh screen. Above this there is a 4-in. layer of gravel passing a ¼-in. and retained on a ⅛-in. sq. mesh screen. The mechanical analysis of the fine gravel is as follows:

60% finer than	4.9 mm.
50% " "	4.25 mm.
10% " "	1.9 mm.
Uniformity coefficient	2.58

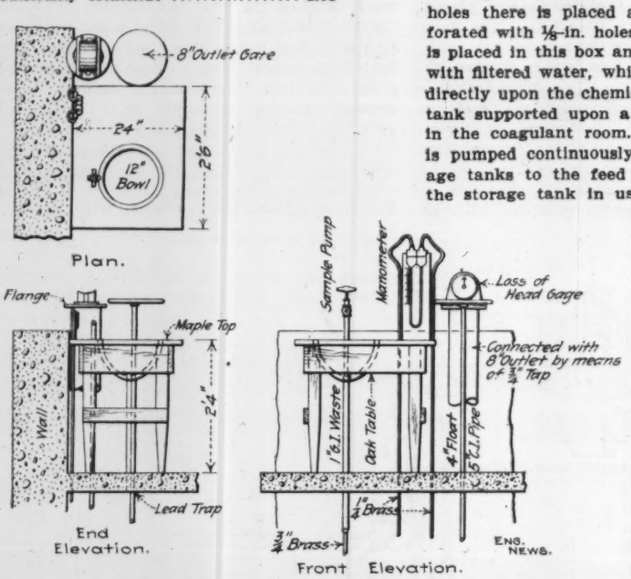


FIG. 4. TABLE AND FITTINGS FOR INSPECTING FILTER OPERATIONS.

SAND LAYER.—The sand in the filters is unusually fine for use in rapid filters. It was obtained by sieving and washing a local bank sand. It has an effective size of 0.24 mm. and a uniformity coefficient of 1.52. The layer is 32 ins. thick. It is practicable to use this fine sand at Exeter on account of the low rate (75,000,000 gals. per acre per day) at which the filters are being operated; they are designed for a 125,000,000 rate.

FILTERED WATER WELL.—The old pump well, 40 ft. in diameter and 25 ft. deep, was thoroughly cleaned and is used as a filtered water well.

WASH WATER.—A 4-in. main supplies filtered water under stand-pipe pressure to an 8-in. ejector, which discharges it into the underdrains of either filter at will. The flow of water from the stand-pipe through the ejector lifts a certain amount of water from the clear water basin and the mixture is used to wash the filter. This arrangement does away with pressure reducers and lessens the cost of pumping the wash water, because only a part of the wash water used (depending upon the economy of the ejector) has to be pumped into the stand-pipe. It also displaces the wash water pump ordinarily used, and for small plants seems preferable to a steam driven pump, as it is ready for instant use.

COAGULANT DEVICES.—(See Figs. 3 and 6). —Two tanks, 3 ft. 2 ins. × 2 ft. × 13.5 ft. deep, are built into the pipe gallery, one on each side of the steps leading to the coagulant room. These tanks are of reinforced concrete, with walls 4 ins. thick. A 2-in. earthenware drainage cock is placed at the bottom of each tank. The tops of the tanks are flush with the floor of the coagulant room. Two cast concrete dissolving boxes, 18 × 24 × 12 ins., were built into the tanks near their tops. The bottoms of these boxes are perforated with ½-in. holes, 12 ins. c. to c., and over the holes there is placed a hard rubber plate, perforated with ⅛-in. holes, 1 in. c. to c. Coagulant is placed in this box and the tank is slowly filled with filtered water, which falls from a ½-in. pipe directly upon the chemical. An earthenware feed tank supported upon a concrete stand is placed in the coagulant room. The coagulant solution is pumped continuously from either of the storage tanks to the feed tank, and overflows into the storage tank in use, thereby maintaining a constant level in the feed tank. This is effected by means of a ¾-in. bronze centrifugal pump, driven by a 12-in. Pelton motor, the latter taking water from the 4-in. pressure main and discharging it into the coagulating basin. The suction pipe is of hard rubber where it dips into the solution, but the rest of the coagulant piping is of lead-lined iron or brass. The coagulant is fed through standard, interchangeable orifices, which are screwed into a brass tee connected with the bottom of the coagulant feed tank. These orifices are ordinary brass pipe plugs bored to various sizes and counter-bored so as to form sharp-edged orifices. They were standardized by experiment. The coagulant is fed into a 1-in. lead pipe, which discharges into the coagulating basin near the outlet of the float valve. The rate of coagulant feed is about 1 grain per gal. of water filtered.

Fig. 5. Overflow Troughs in Mechanical Filters, Exeter, N. H.

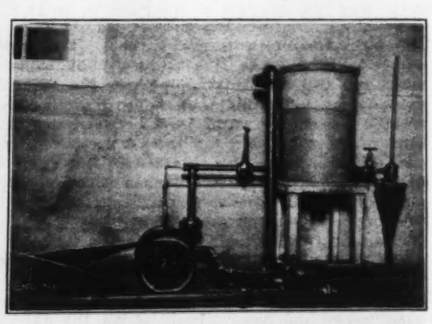


Fig. 6. Coagulant Feeding Device, Exeter Water Purification Plant.

COST.—The plant will cost about $15,000, including all connections and engineering, or about $15,000 per 1,000,000 gals. daily capacity.

DESIGN AND CONSTRUCTION.—The plant was designed by the writer, with the assistance of Mr. G. A. Sampson. Mr. Richard K. H. was the resident engineer during construction and helped to put the plant into service. Excavation, concrete work and carpentry were performed by the Aberthaw Construction Co., on a cost-plus-a-fixed-sum basis. All other parts of the structure were purchased from regular dealers in supplies or have resulted from work performed by Mr. C. H. Johnson, Superintendent of the Exeter Water-Works, employing local day labor. This latter includes all the pipe work.

OPERATION.—The filters were started in December, 1906. They are stopped and started three or four times daily in order to accommodate the pumps, also operated intermittently. The appearance of the effluent is excellent. The accompanying analysis shows the degree of purication obtained.

The odor disappears in great part before the water reaches the consumer. Since starting the filters, complaints about the appearance of the water have ceased and the operation of the plant has been satisfactory.

ANALYSES OF WATER BEFORE AND AFTER PURIFICATION, EXETER, N. H.

(Parts per Million.)

Point of Sampling.			Reservoir.	Filter Effluent.
Date of collection			May 14	May 14
Date of examination			" 15	" 15
Odor	Hot		4. vegetable	3. vegetable
	Cold		2. "	2. "
Turbidity			40.	1.
Color—Hazen's standard			35.	5.
Oxygen consumed			6.45	2.5
Nitrogen as	Albuminoid	Total	0.172	0.098
		Suspended.	0.016	0.000
	Ammonia	Dissolved.	0.156	0.098
	Free ammonia		0.016	0.014
	Nitrites		0.001	0.000
	Nitrates		0.05	0.05
Chlorine (Normal 3. to 4.)			3.	3.
Hardness			26.	24.
Alkalinity			15.	7.
Residue on evaporation	Dissolved		34.	28.
	Suspended		15.	0.
	Total		59.	28.
Iron			0.70	0.10

COST OF SHOP DRAWINGS FOR STRUCTURAL IRON AND STEEL.*

By RALPH H. GAGE.

The following data were gathered by the writer while in charge of the drafting department of A. Bolter's Sons' Structural Steel & Iron Works, of Chicago, Ill., during the years 1904, 1905 and 1906. The works are divided into three different departments: the structural shop, the architectural shop and the foundry. The first has a capacity of 800 tons per month. The drafting department employs on an average seven or eight engineers. All the work is standardized with regard to details to as great an extent as possible, in order to decrease the work in the drafting room, yet not to such an extent that it would be difficult for the shop men to read the drawings. For example, all beams, steel and cast-iron column connections, with the exception of special cases, are not drawn and dimensioned completely, but merely indicated. The shop and drafting room have been provided with a set of the firm's standards, which have all these connections drawn out completely with dimensions and which give lists of the material.

The figures here presented were taken from a great variety of work. Table I shows the character of the buildings and also the average cost of preparing the drawings. The cost of drafting material and blue prints is not included. Where the material for the work is to be ordered from the mill and not taken from stock, the cutting bills or mill orders are taken as being part of the details. Table II shows some of the particulars of the buildings from which the data in Table I were derived and the following notes give additional information about some of the work.†

1. This was a fire escape of unusual size, composed almost entirely of angles, and designed for a seven-story building. It was a very light structure having railings and balusters of 1 × 1 × ¼-in. angles. This accounts for the high cost per ton for the shop drawings. The details were made of the fire escape assembled and not separate details of each piece.

2. The cost of the Miller Brewing Co.'s stock house was unusually low, only 13 cts. per ton. The building consisted of very heavy I-beams, 15-in. 60-lb., and 20-in. 80-lb. Separate details were made of each piece, but as there were many duplicates, the cost was low.

6. The Wolf building, while composed of riveted steel

*Abstract of a paper in "The Technograph," University of Illinois, Urbana, Ill. No. 21, 1906-07.

†We give the figures for about half of the buildings listed in the paper.

TABLE I.—COST OF SHOP DRAWINGS.

Type.	Character of Building.	Aver. Cost Per Ton.
A	Entire skeleton construction; loads all carried to the foundation by means of steel columns	$1.45
B	Interior portion supported on steel columns; exterior walls carry floor loads and their own weight	1.22
C	Interior portion carried on cast-iron columns; exterior walls support floor loads as well as their own weight	.70
D	No columns and floor beams resting on masonry walls throughout	.85
E	Structure consisting mostly of roof trusses resting on columns	2.47
F	Structure consisting mostly of roof trusses resting on masonry walls	1.25
G	Mill buildings	2.56
H	Flat one-story shop or manufacturing buildings	.74
I	Tipples, mining structures or other complicated structures	4.88
J	Malt or grain bins and hoppers	2.47
K	Remodeling and additions where measurements are necessary before details can be made	1.87

columns, beams and trusses, was square and the various pieces had many duplicates.

12. The White City Tower consisted of 16 riveted steel columns rising to a height of about 250 ft. above the ground, with an elaborate system of diagonal angles for wind bracing. There were no floor systems throughout the entire structure. During the erection of this tower not a single piece had to be cut or a hole drilled, and only two holes had to be reamed in the field.

13. This was similar to the ordinary coal tipples. The details were made of the structure assembled, and show all necessary views and sections.

14. The trainshed was composed of a long row of trusses resting on masonry walls and anchored to same, with a hip roof at one end and vertical framing for glass at the other end.

16. The Welch church consisted of a very complicated hip and valley roof whose trusses rested on steel columns built in the walls.

19. The Diversey Boulevard church was composed of a hip roof, but the trusses rested on and were anchored to the masonry walls.

20. The Lawrence Avenue pumping station consisted of trusses supporting a hip roof resting on masonry walls, a crane runway of 24-in., 80-lb. I-beams resting on Z-bar columns, and floor beams resting on concrete walls.

22. The structure was very complicated, and consisted of a long steel flume supported by a bridge-like truss, and other placer mining devices, such as sluice gates, grizzleys. The structure was of comparatively light weight, and there being no duplicate parts, the cost of details was high.

27. This bottling house is a fireproof structure with two floors and a roof. The floor beams rest on the exterior masonry walls and frame into cast-iron columns on the interior. The roof is supported by small trusses resting on cast-iron columns and the exterior walls.

28. The Ward building was a store and office building built partly over a small river. The foundations for the columns were laid in the river bed, and those columns which came in contact with the water were made of cast iron and braced in all directions with 1¼-in. sway rods, while the remaining columns were of steel. Riveted plate girders under the first floor spanned the river which flowed almost directly under the building.

31. The DuPont building was a warehouse of the ordinary skeleton construction and very plain and square. All the columns were practically alike, and the beams were similar for all floors, hence the low cost for the details.

33. This bridge consisted of a double bridge or passageway across an alley connecting two buildings. As the walls of each building were only curtain walls, the girders rested on columns next to the walls running from the ground up. All measurements such as floor heights and distances between walls had to be taken at the building, and the expense incurred for taking these measures is included in the cost of details.

38. While the library was a low two-story building with all floor beams and trusses resting on masonry walls (except for a few interior cast-iron columns), it had a very crooked hip and valley roof, also suspended ceilings and skylights. The ceiling and skylight were made of small tees and channels, and hung from the roof trusses.

40. This stable was a three-story building constructed so that the second and third floors were suspended from the roof, thereby leaving no columns to obstruct the main floor. The roof trusses spanned about 60 ft. and were correspondingly heavy.

41. The hospital was a strictly fireproof structure composed of cast-iron columns and steel floor beams. The roof was a hip and valley roof made up of channels, beams and tee iron, which in turn were covered with tile.

42. The foundry building was constructed on the common mill building plan with riveted steel columns, trusses, crane runway, purlins, and bracing.

45. The annex, while a small building containing only 39 tons of structural steel, has a complicated hip roof with dormer windows. The entire roof was covered with angles 1½ ins. × 1½ ins. × ¼-in., all fitting around the dormer roofs for Ludowici tile.

48. The St. Stanislaus Hall building consisted mostly of large plate girders and high A-shaped trusses.

49. The Gould elevator is a large grain elevator with reinforced brick sides and steel hopper bottoms. The hoppers were made of $^{5}/_{16}$-in. steel plates and were supported by heavy plate girders, which in turn rested on the exterior masonry wall and on interior steel columns. The plates for these hoppers, some of which were 16 ft. square when assembled, were all shipped loose and assembled at the building.

51 and 54. The stock-house and bottling-house were both constructed with very heavy floor systems and cast-iron columns. The buildings were square and required few details, as most of the floor beams were alike.

52. The tank support was of the ordinary four-post construction. The posts were made of beams and had a slight batter. The bracing was composed of angles.

53. The foundry building was mostly roof-truss work consisting of 120-ft. trusses resting on masonry walls with a cast-iron column in the center. Suspended from these trusses was a beam trolley-track with a number of curves and switches which made the detailing more expensive than it would have been for ordinary roof truss work.

There is always a noticeable decrease in the cost of the details when the plans for the ironwork are made and designed by an engineer and separated from the general plans. On comparing the cost of picking out the structural steel and making the shop drawings from the architect's plans and the engineer's plans, it was found that the cost of the former is on an average of 35% higher than the latter. Where the engineer's plans are made with no dimensions, with only the outline and sections given, it being necessary to refer to the general plans for the location and dimensions, there is no saving of time, and the detailing runs as high as on the architect's plans.

Inaccurate plants, where the draftsman is continually finding errors, cause an increase in the cost, as it is necessary to wait and refer the matter to the architect. In most cases he, in turn, has to check over his plans before he can settle the question, all of which causes considerable delay and takes time that might otherwise be spent in making the drawings.

The cost of structural steel details depends on so many things that it is hard to set any fixed rule for determining what this cost is. The type of the building is the first consideration; then the architect and engineer, their methods of drawing up their plans; and finally the detailing drafting force one is obliged to depend upon.

TABLE II.—DETAILS OF STRUCTURES SUMMARIZED IN TABLE 1.

Item.	Structure.	Type.	Weight Tons	Cost of Details	Cost per Ton	Remarks.
1	F. H. & G. Building, Kansas City, Mo.	I	17.0	$85.80	$5.05	Fire escape
2	Miller Brewing Co., Milwaukee, Wis.	C	295.0	38.20	.13	Stock house
3	Lincoln Park Aviary, Chicago, Ill.	E	33.0	17.80	.54	Bird and animal house
4	Metropolitan Elev. Ry., Chicago, Ill.	A	113.0	131.60	1.17	Terminal station
5	Dahl Building, Chicago, Ill.	B	35.0	44.75	1.28	Apartment building
6	Fred W. Wolf Building, Chicago, Ill.	A	280.0	78.50	.28	Machine shop
7	Wahl-Henius Institute, Chicago, Ill.	C	29.0	35.50	1.22	Brewer's school
8	St. Nicholas Church, Evanston, Ill.	D	29.0	24.00	.83	Church
9	National S. & E. Co., Chicago, Ill.	D	181.0	93.40	.51	Warehouse
10	Crane Co. Building, Chicago, Ill.	C	108.0	61.00	.57	Office building
11	Schott Building, Chicago, Ill.	B	22.0	25.00	1.14	Apartment building
12	White City Tower, Chicago, Ill.	A	260.0	723.00	2.78	Ornamental tower
13	Newaygo Portland Cement, Newaygo, Mich.	I	7.5	32.00	4.26	Tipple
14	Sears-Roebuck & Co., Chicago, Ill.	F	427.5	319.00	.75	Trainshed
15	Nelson-Morris Co., Kansas City, Mo.	D	50.0	58.60	1.17	Boiler house
16	Welch Pres. Church, Chicago, Ill.	E	22.0	77.00	3.50	Addition
17	Missoula Mercantile Co., Missoula, Mont.	D	23.0	27.50	1.20	Stock house
18	Chicago Dock & Canal, Chicago, Ill.	C	179.0	82.60	.46	Mill construction
19	Diversey Blvd. Church, Chicago, Ill.	F	34.5	94.40	2.74	Church
20	Lawrence Ave. Station, Chicago, Ill.	E	115.0	166.50	1.45	Pumping station
21	People's Gas L. & C. Co., Chicago, Ill.	C	21.5	26.00	1.21	Gas house
22	Convey Placer Min. Co., Ruby, Mont.	I	47.0	378.00	8.45	Steel flume & bridge
23	Western Foundry Co., Chicago, Ill.	F	81.0	34.00	.42	Foundry
24	Las Vegas Elec. Ry. Co., Las Vegas, N. M.	F	31.5	24.30	.77	Car barn & Power-house
25	Western Electric Co., Chicago, Ill.	A	93.0	40.00	.43	Factory
26	French Lick Hotel, French Lick, Ind.	D	52.5	30.00	.57	Sanitarium
27	Minneapolis Brw. Co., Minneapolis, Minn.	C	534.0	303.00	.57	Bottling house
28	Jos. M. Ward Bldg., Battle Creek, Mich.	B&C	50.0	324.00	6.50	Office building
29	Stephen Hayt School, Chicago, Ill.	C	465.0	429.00	.93	Public school
30	Malt bins, Columbus, O.	J	19.0	68.40	3.60	Steel bins & hoppers
31	Col. DuPont Building, Chicago, Ill.	A	119.0	32.00	.27	Warehouse
32	South Bend Gas Co., South Bend, Ind.	C	28.0	24.30	.87	Gas house
33	Carson, Pirie, Scott & Co., Chicago, Ill.	K	28.0	121.50	4.35	Bridge
34	King Joy Lo Co, Chicago, Ill.	K	61.0	64.50	1.05	Restaurant
35	National Machine Wks., Chicago, Ill.	H	51.0	68.00	1.33	Machine shop
36	Western Electric Co., Hawthorne, Ill.	H	388.5	171.00	.44	Shop and kiln bldg
37	The Beach View Bldg., Chicago, Ill.	B	16.0	24.00	1.50	Apartment building
38	Evanston Library, Evanston, Ill.	B&E	129.0	570.00	4.47	Public library
39	Feeble M'd & Epil. School, Marshall, Mo.	D	70.0	68.00	.97	School and asylum
40	Knickerbocker Ice Co., Chicago, Ill.	F	65.5	81.00	1.24	Stable
41	Oak Park Hospital, Oak Park, Ill.	C	250.0	480.00	1.92	Hospital
42	Otis Elevator Co., Chicago, Ill.	G	76.0	82.60	1.09	Foundry
43	C. & N. W. Ry. Shops, Chicago, Ill.	F	64.0	44.00	.69	Locomotive shops
44	Ulrich Bros. Bldg., Evanston, Ill.	C	80.0	45.50	.57	Store and office building
45	Garrett Biblical Inst., Evanston, Ill.	B	39.0	231.00	5.93	Library annex
46	North Ave. State Bank, Chicago, Ill.	B&C	30.0	58.75	1.96	Store and office building
47	Chicago Telephone Co, Chicago, Ill.	B	73.0	54.70	.75	Branch exchange
48	St. Stanislaus Hall, Chicago, Ill.	F&B	153.5	250.30	1.63	Hall and school building
49	Gould Elevator Co., Minneapolis, Minn.	J	111.0	93.50	.84	Grain elevator
50	Birk Bros. Brewing Co., Chicago, Ill.	C	38.5	35.00	.91	Bottling house
51	Fred Miller Brew. Co., Milwaukee, Wis.	C	32.0	52.00	.16	Stock house
52	Ailing Construction Co., Chicago, Ill.	I	10.0	58.00	5.80	Tank support
53	Western Foundry Co., Chicago, Ill.	F	102.0	162.50	1.59	Foundry
54	Miller Brewing Co., Milwaukee, Wis.	C	720.0	100.00	.14	Bottling house
55	Knickerbocker Ice Co., Chicago, Ill.	E	41.5	46.00	.96	Refrigeration plant

NOTES ON ENGLISH RAILWAY TRACK.

It is often said that English railway track is superior to that of American railways. The superiority did undoubtedly exist at one time, but while English track has remained practically unaltered for 20 years or more (except for some increase in weight of rails), American track construction has been greatly improved during the same time. The weakness in American practice lies in the limited mileage to which really first-class construction has been applied.

As a result of a recent examination of railways in both countries by a member of the editorial staff of this journal it may be said that English track construction still shows to advantage in comparison with American track in some respects. In the first place, it is, as a whole, in better relation to the weight and traffic which it carries, although the somewhat extensive introduction in England within the past two or three years of locomotives of much greater weight and power than those formerly used, seems likely to produce a change in this respect. In the second place, the ballast is much heavier and better than is commonly found in this country. In the third place, the chair supports necessary for the English type of rail undoubtedly give better fastening of the rails which adds materially to the security of the track on curves. In the fourth place, the roadway is as a whole kept in better condition: banks are of full width, so that ballast does not extend to the edges; ditches and ballast slopes are clean and properly trimmed, and there is evidence that the line is well policed. The track of the Great Northern Ry., which is typical of modern construction, being laid with 100-lb., 45-ft. rails, is shown in the accompanying cuts. Fig. 1 is a part plan and elevation; and Fig. 2 shows the joint chairs and intermediate chairs which carry the rails.

The English rails weigh from 85 to 100 lbs. per yd., and are of the bull-head type, in which the lower head is of similar section to but smaller than the running head. It is claimed that this type of rail is better adapted to the process of rolling than is the T rail with its wide and comparatively thin flanges, but there is little doubt that equally good rails of the T section can be rolled. In fact, these latter rails are used on continental railways and in all other parts of the world, England being practically the only country to retain the bull-head section. The troubles with heavy rails of American railways do not appear to be due in any way to the form of section. Rail breakages are not infrequent on English railways, and are influenced to some extent by the long span between tie supports and probably also by the rigid bearing upon the cast-iron chairs.

In ordinary track, the bull-head rails rest in cast-iron chairs weighing 40 to 55 lbs. each, and are secured by wooden wedges or keys driven between the web of the rail and one side of the chair; the rail rests directly against the other side of the chair. This arrangement, together with the long-span rail joint, accounts to some extent for the noise and the uncomfortable riding of the cars, although this has been reduced somewhat by the more general use of trucks under

the cars. The chairs give a very large bearing on the ties (about 100 sq. ins. to each chair), and are secured to them by round spikes (about ¾ × 6 ins.) and wooden trenails driven into bored holes. If properly fastened, the chairs certainly hold the rails well on curves. In many cases only two fastenings are used, but holes are provided in the chair for four fastenings. They sometimes work loose under traffic, and, of course, any lateral movement affects the gage of the track, which it may be difficult to adjust.

The joints are very noticeable and noisy, even on the best roads. This trouble is due largely to the long overhang of the rail ends and the use

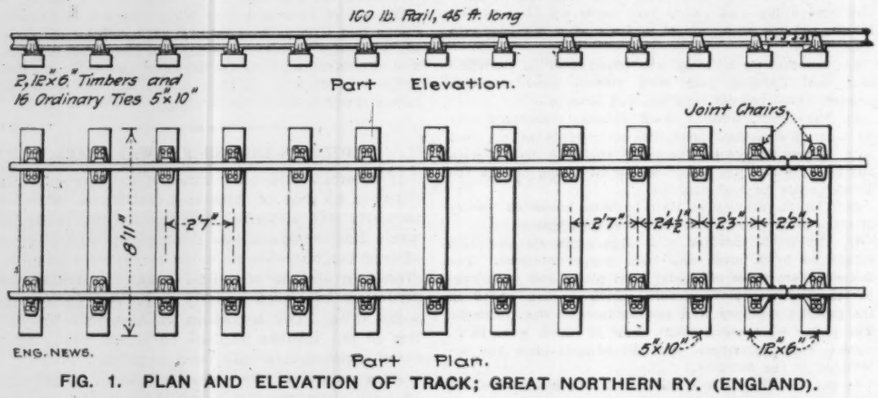


FIG. 1. PLAN AND ELEVATION OF TRACK; GREAT NORTHERN RY. (ENGLAND).

of shallow flat splice bars, although some roads use deep bars with flanges extending beneath the rail. On the Great Northern Ry. the 100-lb. 45-ft. rails are laid with square joints on shoulder ties 12 × 6 ins., spaced 26 ins. c. to c., as shown in Fig. 1. To reduce the overhang, the joint chairs have the rail seats 10 ins. long (instead of 7½ ins.), so that the overhang of each rail is about 8 ins. Short flat splice bars are used, fitting between the upper and lower heads of the rail, and having four bolts. The use of chairs prevents the use of long splice bars.

The ties appear to be a weak point in English railway track, being only 5 ins. thick, and spaced 26 to 32 ins. c. to c. The almost universal size is 5 × 10 ins., as it was 20 or 30 years ago. Under the heavy loads of modern locomotives there is undoubtedly considerable deflection, causing disintegration and disturbance of the ballast, so that the ties are liable to lack a uniformly firm support. Such conditions are apt to be conducive to derailment. In this country, 6 ins. is practically the minimum thickness for ties. Many railways require ties 7 or 8 ins. thick for main track, while 7 ins. has been recommended by the American Railway Engineering and Maintenance of Way Association. It is true that the English ties are 10 ins. wide, while widths of 8 and 9 ins. are usual in this country. A tie 6 × 8 ins. is clearly stiffer than a tie 5 × 10 ins. (laid flat), and as the former are more closely spaced than the latter, they give a better bearing in the ballast. The actual bearing of the English rail in each chair is about 2½ × 7 ins. An American 100-lb. rail on an 8-in. tie has a bearing of about 6 × 8 ins., or perhaps 6 × 6 ins. if tie-plates are used.

The ties of English railways are almost invariably of Baltic fir, creosoted, but some Australian timbers are being introduced. Steel ties were tried experimentally several years ago, but it is doubtful if any now remain in main track. Some rusty steel ties were seen in sidetracks at a number of stations on a London suburban extension of the Metropolitan Ry. Gravel ballast is very generally used, but is washed or screened, and is practically as good as ordinary stone ballast. Broken stone and slag are also used. As a rule a foundation course of large stones is laid on the roadbed (as in Telford road construction), to maintain good drainage and to prevent the ballast proper from working into the roadbed. This gives a good firm base, and ensures economy in maintenance work and subsequent ballasting. In other cases a bed of broken brick or coarse cinders is laid for the same purpose. The ballast is either flush with the tops of the ties, or covers them to a depth of about 2 ins.; it is usually extended or shouldered out about 12 ins. beyond the ends of the ties.

A marked peculiarity in English railway track is the entire absence of spring-rail frogs. They appear to be considered dangerous devices on account of being movable, although long experience in this country has shown that they are fully as safe as the switch itself. The ordinary rigid frogs are very noticeable in passing turnouts and crossovers.

The roadway is kept in good condition, and well policed. Trespassers cannot easily get upon the track and would be promptly driven off or arrested by the first employee. Consequently there is very little trespassing and no such dangerous and unwarranted use of the railway for a public footway, as in this country. The ballast slopes are well trimmed, and screenings are laid at the sides. The slopes of banks and cuts are well grassed and trimmed. Wet cuts are numerous, and are drained by stone-filled trenches laid up the slope, while stone paving also prevents erosion at bare spots. In several cases the clay of the slope is burned in place, and the hard material spread over the slope. The drains laid up the slope are sometimes connected by horizontal intercepting drains laid between them, half way up the face of the slope, these latter being inclined slightly to deliver the water to the main drains on either side. Tile drains are laid in ditches filled with coarse broken stone. In some cases banks that have bulged or slipped through getting saturated, have stone drains laid down the slopes to drain off water quickly.

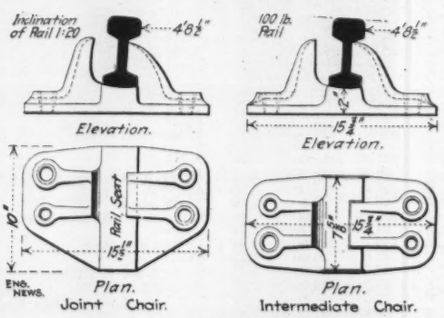


Fig. 2. Joint and Intermediate Chairs for Rails; Great Northern Ry. (England).

Railway fog signaling seems to have made but little progress in England, in spite of the fact that at certain times of the year fogs are very prevalent, and that many accidents have occurred owing to enginemen having failed to observe signals obscured by fog. In the open country the usual practice is to call out the section men (which may mean sending a messenger for a considerable distance), and to station them at the signal posts equipped with torpedoes. Accidents happen before the "fog-men" are at their posts, and even while they are on duty, and the system is an inefficient one at best. Along some lines near cities, cabins for fog-men have been installed, hinged so as to lay on the ground when not in use. A few railways make li[mited] use of automatic fog-signal apparatus, wh[ich] in times of fog is connected up to the signa[l] apparatus and places a torpedo on the rail wh[en] the semaphore is set at the "stop" position. [Re]moving it when the signal is changed to the [cl]ear" position. On busy sections of line, a[s] near London, some railways have miniature [se]maphores placed between the rails to show [to] fog-men the position of the main signals, an[d] by means of a lever the man operates an appa[ra]tus which places a torpedo on the rail or remov[es] it, as required.

In all these cases, however, no torpedo is used when the signal is at the clear position, and this is an element of danger, as it gives the engineman no notice of the location of the signal he is passing. Even if he can see the post but not the semaphore, and does not hear a torpedo, he may assume that the signal is "clear," when in fact it may be at "stop," only there is no fog-man on duty. Experiments have been made on the Great Western Ry. with an apparatus that will give distinct audible signals for both positions of the semaphore, thus positively notifying the engineman when he passes a signal and what is its indication. Nevertheless, in spite of numerous accidents and frequent warnings from the government inspectors who have reported on these accidents, the railways continue to rely almost entirely upon the old and ineffective system of fog-men with hand torpedoes.

REPAIRING A LIMESTONE-CONCRETE AQUEDUCT LINING DESTROYED BY SOFT WATER.

The peculiar destroying action of a soft water on a limestone-concrete is the subject of a paper by Mr. M. R. Barnett in a recent number of the "Proceedings of the Institution of Civil Engineers." The Thirlmere Aqueduct, which carries an additional water supply for the City of Manchester, England, runs for about 51 miles of its 95 miles length through a concrete lined tunnel. A portion of this tunnel, a section of which is shown in the accompanying figure, is formed of a concrete with the aggregate made of the local carboniferous limestone.

The aqueduct was first opened for use in 1894 and for a short time delivered the water as designed. In a few years the flow at the reservoir end became considerably lessened and a cursory investigation showed a leakage taking place in the limestone-concrete culvert portion at a place called Hutton Roof in a length of about three miles. For three years patching was resorted to along this section, but as no especial pains were taken to find the position of the leaks the work did not prove successful. This repairing was done with a Roman cement, on account of its quick setting properties, and the cement was placed neat without any sand. Wherever any suspicious place appeared the old concrete was picked out and a patch supplied. The ineffectiveness of this work was well shown in the latter repairing, for each one of these patches was comparatively soft and could be easily scooped out, while in many cases the water had worked itself back of the patch and into the old concrete.

Finally, in 1902, the leakage became so marked that radical action was necessary and the work of repair, noted in this article, was started. After a careful investigation of the situation Mr. Barnett, who was in charge of this new work, came to the conclusion that the leaks were caused by a deterioration in the limestone in the concrete. He based his opinion on the following circumstances:

1. The local limestone is a surface rock and entirely bare of cover, indicating that it is a very pure limestone and therefore readily soluble. 2. The water coming off this limestone is very hard, indicating the presence of a considerable amount of carbonate of lime held in solution by an excess of carbonic action. 3. A large number of stalactites, such as are usually found in limestone caverns, were present in the aqueduct, and large quantities of a similar deposit were found on the side walls of the culvert.

After the work of repairing was finished a large amount of fine flowry sediment was found to have been deposited on the bottom of the

aqueduct. This sediment was soft and impalpable, with no feeling of grittiness and, moreover, it was again deposited in the clear water after the cleaning out had been accomplished. This proved that the water was having a chemical action upon the concrete.

When the aqueduct was first completed it was separated into small divisions by temporary bulkheads and each division was then filled with water to its high water level and allowed to stand for a few days. The entire aqueduct was at that time found to be perfectly water tight. The first step in this investigation of the leakage was to repeat this test. For this purpose the entire concrete section of the aqueduct was subdivided into lengths of about ⅝-miles each, by wooden bulkheads reaching nearly to the top of the conduit. The bulkheads were each provided with a door near the bottom through which the water passed during the intervals when the aqueduct was in service.

The water was then let into the whole length until it had reached the top of the bulkhead in each subdivision, when it was shut off at the intake. Readings were taken on the bulkheads throughout the next 24 hours with the result that the leakages in the eight subdivisions were found to vary from 847,000 gals. to zero; the total leakage for the whole limestone-concrete portion totaling 1,235,000 gals. in the 24 hours. The next largest leakage to the 847,000 gals. was only 160,000 gals. So it will be seen that most of the trouble occurred at the former place.

As soon as the water was let out of the conduit an examination of the interior was made. It was found that in all places where the limestone aggregate in the concrete was exposed to the action of the water it was worn away into a concave shape, all the stones being quite hollow, while the mortar surrounding the stones remained good and stood up round each stone. The small stones which formed part of the sand and were not limstone were not affected by the water, but stood level with the original surface of the floor. Also, whereas the surface of the concrete above water level remained in the same fairly smooth state as when originally put in, all portions below the water line were pitted and honeycombed. In many places holes 1½ to 2 ins. in diameter were found through the concrete lining, and as the limestone backing was very loose and open, these holes formed exits through which the water ran as through the vent hole of a wash bowl.

To further substantiate the theory that the limestone was being destroyed by chemical action of the water and not by the physical action of the running water a series of experiments was made upon specimen blocks of the various stones and concretes making up the aqueduct, in which each of these blocks was left in the water for a certain length of time and the effect upon it noted. Eight test blocks of limestone showed a loss in weight varying between 6.8% and 18.1% per annum in a 3-months' immersion and between 6.75% and 17.09% per annum in a 6-months' immersion. The cement and mortar blocks showed an increase, however, instead of a decrease in weight. When taken out of the aqueduct after 3 months' immersion the neat cement block had gained 5.47% and the block of mortar (1 cement: 1 sand) had gained 3.57%. The water, therefore, has no adverse action upon cement or mortar.

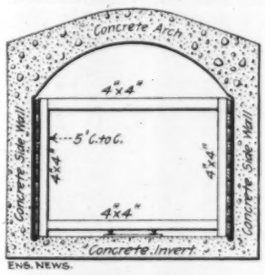
The water analyzed as follows:

Total Solid Matter—Grains per Imp. gallon	3.200
Chlorine—Grains per Imp. gallon	0.504
Nitrogen as Nitrates and Nitrites—Grains per Imp. gallon	4.000
Nitrogen as Ammonia—Grains per Imp. gallon	0.000
Oxygen required to oxidize organic matter—Grains per Imp. gallon	0.080
Degree of hardness	2.18
" " " after boiling ¼ hour	2.18
Organic Carbon (parts per 70,000)	0.001
Organic Nitrogen (parts per 70,000)	0.010

METHOD OF EXECUTING REPAIRS.

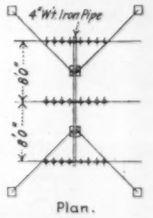
When it had been fully established that the leakage was due to the action of the water on the limestone in the concrete, it was decided that the entire water surface of the concrete lining in which limestone had been used should be protected by an impervious lining. It was first thought advisable to use blue bricks, but this involved too great an expenditure of time and money, so it was finally decided to reface the whole of the limestone concrete with a cement mortar lining not less than 1 in. in thickness.

Those lengths were first relined where the leakage was greatest, the water tight places being left for the last. It would have been simpler to commence the work at one end and carry it through to the other, but the way in which it was done prevented, to a great extent, an increase in the amount of the leakage and ensured the stoppage of the loss of water in the shortest possible time. It was arranged at first that the water should be shut off for 36 hours, in which time three 11-hour shifts were worked, having 3 hours in which to refill the aqueduct. This was afterward increased to 48 hours, consisting of four 11-hour shifts with a 4-hour refilling period. One section was completed in this 48-hour period and was left for two weeks to set before the forms were taken down and the next section started.



Form for New Lining to Concrete Aqueduct.

The first operation was to remove the entire surface from the side walls to such a depth as would allow of a minimum thickness of 1-in. of new work; the invert was left until the relining had been applied to the side walls. When the surface had been removed the roughened walls were well washed with water and the forms, as shown in the figure, erected. The ordinary plastering methods without forms could not be used because the 1 to 1½-in. coat could not be made to stick in one layer and there was not time to apply two or three layers; also water had to be run through the conduit immediately after the finish of each section and the forms were needed for protection.

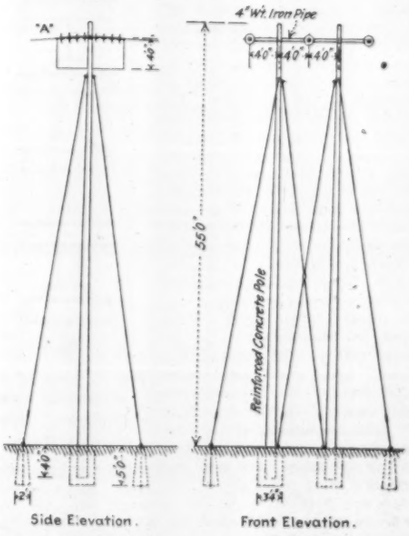


Plan.

The forms consisted of 1¼-in. planed planks about 15 ft. long, placed one on top of the other as the mortar facing rose in height. To prevent the bending of the planks between the ends, and to preserve the proper mortar space until the mortar was put in, small pieces of wood were temporarily wedged between the planks and the side walls. The mortar, a 1:1 mixture, was hand mixed on boards, sliding on rails within the aqueduct, and placed with trowels or small shovels. The bottom layer was made very stiff so as to prevent any leakage at the joint. The remainder was made quite wet and well worked down back of the forms, the planks being tapped with the handle of the trowel to expel the air.

The work was then left for two weeks in the shape shown in the figure. When it was then resumed the forms were taken down and work commenced as before on a new section. Simultaneously the finished section was smoothed up and small cracks and pits plastered. While work was going on on the side walls of the new portion, the invert floor was resurfaced in the finished section. This is a cement mortar floor laid on the cleaned surface of the invert, two or three inches of which were first removed.

The work is not entirely finished at present, but enough has been completed to be sure of its success. The leakage has been stopped in every section where the lining has been built and the overflow pipes are being called into service all along the line.



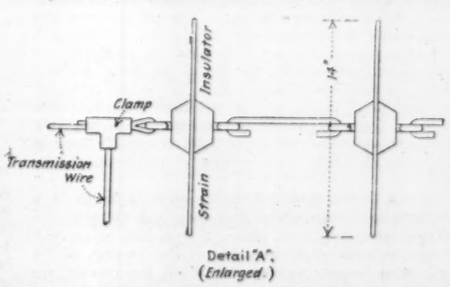


FIG. 1. A NEW METHOD OF HIGH TENSION LINE CONSTRUCTION; DIAGRAMMATIC ARRANGEMENT FOR ONE CIRCUIT.

SOME NEW METHODS IN HIGH-TENSION LINE CONSTRUCTION.*

By HAROLD W. BUCK,† M. Am. Inst. E. E.

The great economies in the cost of generating power which have been obtained in the large steam turbine stations and hydro-electric plants are leading to the general abandonment of small generating stations and the increase in transmission distances in order to distribute power over a large territory. In other words, 100,000 HP. can be generated in one station and transmitted 100 miles cheaper than it can be generated and distributed from ten 10,000 HP. stations near the center of load. On account of this tendency toward the concentration of generating units, the overhead transmission line has assumed a position of great importance in electrical installations, and the same permanency and reliability is demanded of it as of the generating station itself. The wooden pole line of the past has been practically abandoned and steel construction has been substituted.

The long distances required for many of the modern lines, the large amounts of power to be transmitted, and the very high price of copper and aluminum—all have combined to force up the transmission voltage to the highest practicable limit. In consequence the demand for high-voltage overhead line insulators has outgrown the present standard practice, and some new systems will have to be introduced to meet the new conditions.

The method of line construction here described has been developed by the writer and Mr. E. M. Hewlett and is believed to offer a means of operating lines safely at higher potentials than is practicable with insulators of the pin and petticoat type.

Fig. 1 illustrates in a diagrammatic way the arrangements for one circuit. The tower supports shown here are those which were used merely for experimental work, and need not be considered as a commercial design. Each span is dead-ended at each support as shown, through a series of insulating units which in this case are plain discs connected together with steel links. The various spans are then electrically connected by jumpers hung below the insulators. The insulators are directly attached to the cross-arms, eliminating all pins. The number of discs linked together in series depends upon the line volt-

*Presented at the 24th Annual Convention of the American Institute of Electrical Engineers, June 26, 1907. See also paper by E. M. Hewlett, reprinted in this issue.

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age, the discs themselves being identical for all voltages.

Fig. 2 illustrates a design for a 100,000-volt two-circuit line which is soon to be constructed for transmitting 50,000 HP. 165 miles. The spans in this case will range from 500 to 1,000 ft. in length. Here the line is suspended below the cross-arm on most of the towers. The lines will be dead-ended, with jumper connection as shown, only at angles and on tangents at about every fifth tower. This dead-ending will be for the purpose of stopping any creeping of conductors on the line as a whole, to check the transmission of longitudinal waves along the conductors due to wind, and on curves to take the side stress of the conductor due to change in direction. In this installation the lines will not be triangulated, but at suitable intervals along the lines the conductors will be transposed so as to balance up effects of mutual static and magnetic induction. Special cross-arms will be installed at transposition towers.

Fig. 3 illustrates another design for a two-circuit line which is to be built for 80,000-volt operation. The spans in this case will range from 300 to 400 ft. and the conductors will have an approximate triangular relation. The conductors will be suspended by a series of insulators from the cross-arms as in Fig. 2, with occasional rigid attachment, for the reasons given above.

Fig. 4 shows a method of assembly of the insulators for suspension under a cross-arm. Fig. 5 illustrates a method of assembly where spans are dead-ended at the cross-arm with jumper connection.

The advantages of this construction, which might be termed "series unit insulation," over the pin and petticoat type may be summarized as follows:

(a) With the standard type of pin insulator now used the difficulties of construction increase very rapidly at the higher voltages. The cost of insulator for a given margin of safety increases for voltages above 60,000 nearly

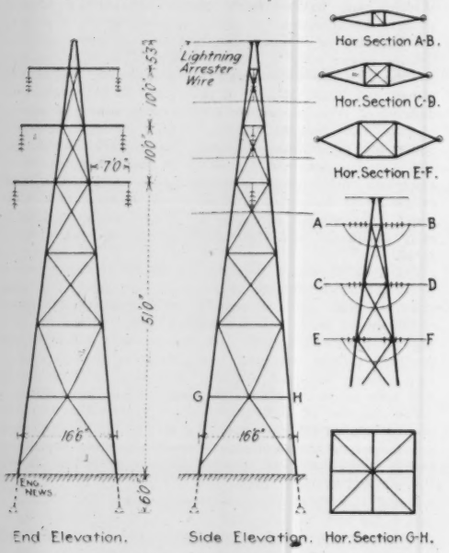


Fig. 2. 100,000-Volt, 2-Circuit Line, with Suspension and Strain Insulators.

as the cube of the increase in voltage. Either very large petticoat diameters must be used, or very high insulators with many petticoats. In either case the manufacture of the porcelain parts is a difficult and expensive matter, and with the long pin necessary the mechanical stresses from the line on insulator, pin and cross-arm are objectionable. With the series unit system here proposed the cost of insulators progresses only in direct proportion to the increase in voltage, the only change being in the number of units in series. There is practically no limit to the degree of insulation obtainable.

(b) One of the most difficult elements of design in a transmission tower where long pins and petticoat insulators are used is to obtain a cross-arm which will resist the torsional stresses due to the leverage of the pin. With the pin entirely eliminated, the stresses are directly applied to the cross-arm; this cheapens the construction of the tower.

(c) In the arrangements shown where the insulating units are attached on either side of the cross-arm, taking the full tension in the line with jumper connection between spans, the insulation can be increased indefinitely by adding discs in series without increasing the space occupied on the tower.

(d) Where each span is dead-ended, as in (c), all faces of the insulating units are exposed to the cleansing action of the rain, so that dirt cannot accumulate thereon. This arrangement also prevents the dripping water from forming electrical communication between units as occurs from one petticoat to another in the pin type of insulator.

(e) A standard insulating unit can be adopted for all voltages, the only variation being in the number linked in series. This simplifies the manufacturing problem.

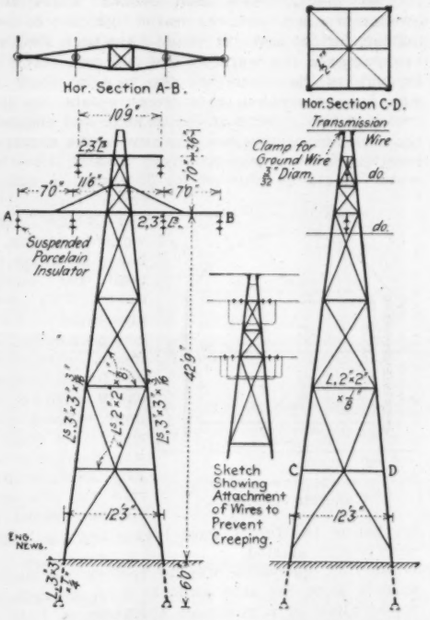


Fig. 3. 80,000-Volt, 2-Circuit Line, Showing Approximate Triangular Arrangement of Conductors.

(f) If any insulating unit becomes damaged or completely shattered the insulation of the remainder is not affected. The damaged unit can be replaced without the necessity of renewing the whole.

(g) If a tower is directly struck by lightning the cross-arms will be likely to take the discharge, since they are above the lines, whereas in the pin type of insulator the line is usually the highest point.

(h) In long-span installations where the conductor at each end of the span is tied fast to an insulator mounted on a pin, experience has shown that crystallization is apt to take place in the conductor at the tie, due to its rigidity at that point and the vibrations in the span. This frequently results in breakage of the conductor. The flexible connection between conductor and cross-arm afforded by the series of insulators should reduce this tendency to crystallization, and should therefore permit spans of any length to be used without further precautions against this action.

Fears may be expressed that with the conductor suspended under the cross-arm serious swinging to and fro might take place. From numerous observations it is believed that no such swinging will occur. Long aerial spans under wind pressure take a permanent and steady deflection throughout the span proportional to the average wind velocity along the span, and no indications have been observed of long spans responding to so-called gusts. The towers shown in this paper are designed so that the conductor can safely be deflected by the wind about 60° on either side of the neutral position.

Fig. 4. Method of Assembling and Attaching Suspension Discs.

Fig. 5. Assembly of Strain Insulators for Dead Ending a Span.

Insulators of a great many forms have been built and tested, but the one which gives the best results electrically and mechanically is the "link type," developed by Mr. Hewlett and having the grooved or fish-tail petticoat. Four of these in series is sufficient for 100,000-volt operation with a liberal factor of safety.

A very important element in this construction is, of course, the method of fastening the insulating units together and attaching them to the line and cross-arms. This can be accomplished in many ways, and several methods have already been worked out; but these details are beyond the scope of this paper. Further experience in practical line construction and operation under this system will demonstrate the best methods of installation and attachment.

A NEW TYPE OF INSULATOR FOR HIGH-TENSION TRANSMISSION LINES.*

By E. M. HEWLETT,† Assoc. Am. Inst. E. E.

The transmission of large amounts of power over long distances has reached such proportions that the voltage necessary to transmit this energy makes the problem of line insulation difficult. The so-called "pin" type of insulator has been enlarged to meet the greater demands until it has approached, if not already passed, the limits of good construction. Mr. H. W. Buck has given this matter a great deal of study in his high-potential transmission work, and, being dissatisfied with the mechanical features of a pin insulator, has devised a method of line construction involving the use of "suspension" and "strain" insulators. The suspension insulators support the line from above, hanging vertically beneath the cross-arm (or other point of suspension). The strain insulators are used at turns and at intervals of, say, every mile, to support and anchor the line, also as pull-off insulators on curves and to dead-end lines.

It is intended in this paper to give some mechanical and electrical tests and describe a porcelain insulator which the writer has designed to carry out this method of supporting of high-potential transmission lines.

Each insulator unit is a flanged or petticoated disc with an enlarged central portion having two interlinked semi-circular holes. It is called a "link insulator" because it is used to insulate the interlinked tie-wires. The holes in the insulator are so arranged that the tie-wires which pass through them exert a compression strain on the porcelain (Fig. 4). Should the insulator break, the loops of the tie-wires will still be intermeshed (Fig. 5), and as the discs are used in series, with a factor of safety, the remaining discs will prevent a ground being formed until the break can be repaired.

The link insulator for suspension (shown in Fig. 1) is a petticoated disc, while the strain insulator (Fig. 2) is a disc with a grooved flange. The mechanical and electrical features of the two forms of insulator are essentially the same. The petticoats and flanges are so arranged that one side of the insulator is always protected from rain.

A diameter of 10 ins. for both types of insulators has been found by experiment to be most convenient, and such insulators are suitable for a working voltage of 25,000 volts per disc. For higher potentials the discs are placed in series; for instance, four 10-in. discs would be suitable for a 100,000 volt line. As the separate discs are over wet at approximately 65,000 volts, the rated voltage of 25,000 volts is within safe limits. The 10-in. discs were tested for mechanical strength, and did not fail with a load of three tons.

The insulators described above being made of one piece of porcelain, no cemented fittings or sections are necessary. They are not affected by extreme heat or cold, having stood the test of a severe winter. Tests prove that insulators with sheltered surfaces stand a much higher rain test than a much larger insulator which has no dry surface, as, for example, a flat disc without the flange or petticoat.

Fig. 3 shows diagrammatically a possible method of line support using ten towers per mile, in which the line is anchored at the end of each mile and at curves, and suspended at intermediate towers. From the cut it will be noted that the conductor is looped around the strain links at the anchorage towers. The use of this type of insulator does away with torsional strain on the cross-arms, giving it a decided advantage over the pin insulator. It is obvious that the link insulator is adaptable to a great variety of conditions.

Fittings have been designed for use with these insulators to fit the conditions thus far presented, but each case should be considered as it comes up and such fittings designed as are necessary.

[NOTE: The General Electric Co. is also making insulators of this type 6½ ins. in diameter for voltages up to 12,000 per disc. This article should be read in connection with Mr. H. W. Buck's article, in this issue, on line construction with this type of insulator.—Ed.]

*Presented at the 24th Annual Convention of the American Institute of Electrical Engineers, June 26, 1907.

†Engineer with General Electric Co., Schenectady, N. Y.

OPERATIONS AND PROCESSES AT THE DE BEERS CONSOLIDATED DIAMOND MINES.

Some interesting facts regarding the De Beers Diamond Mines, in South Africa, are given in a paper by Mr. Edgar P. Rathbone, published in Bulletin 28 of the British Institution of Mining and Metallurgy, issued Jan. 10, 1907.

Some idea of the extent of the De Beers operations may be gained from the fact that they are scattered over an area of about 25 sq. miles, and that the company employs in the neighborhood of 30,000 natives and 3,000 whites at the various surface and underground works. The Wesselton mine is the only open working of the De Beers Co. It covers an area of some 15 acres, and consists of excavations to a depth of about 500 ft. at present.

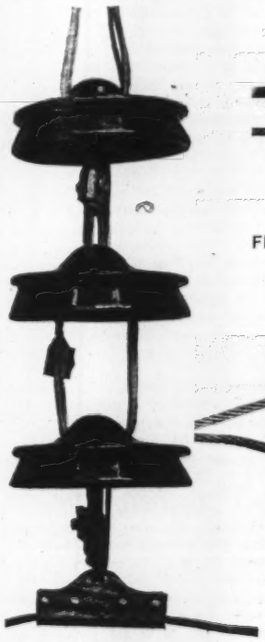


Fig. 1. New Type of Link Suspension Insulator for High-Tension Lines.

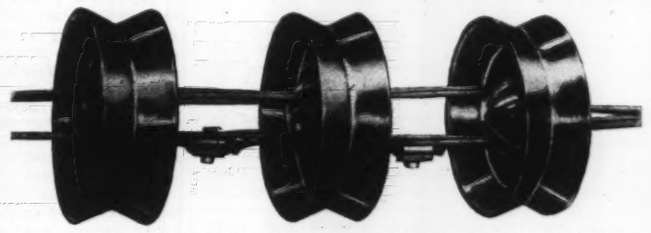


FIG. 2. NEW TYPE OF LINK STRAIN INSULATOR FOR DEAD ENDING CABLES IN HIGH TENSION LINES.

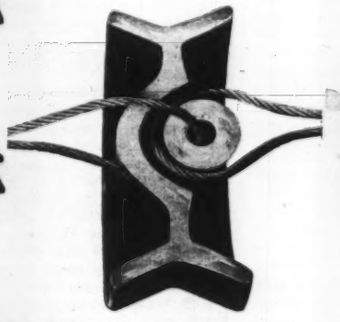


Fig. 4. Section Through Strain Insulator.

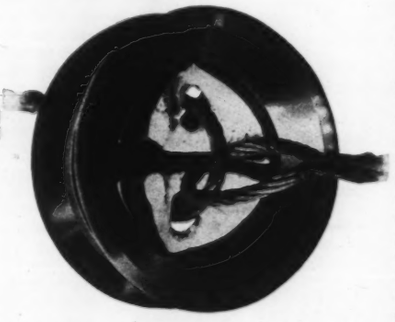


Fig. 5. A Strain Insulator Broken, Showing Interlinking of Tie Wires.

Since the consolidation of the various diamond mines into the De Beers syndicate, the total output has been about 40,000,000 carats, roughly estimated, representing a value of over £80,000,000, or nearly $400,000,000. More than £22,000,000 has been paid in dividends to stockholders.

The first economic point upon which Mr. Rathbone touches is the use of electric haulage and motors underground, together with rapid hoisting. At the Wesselton mine from 8,000 to 10,000 loads of "blue ground" per day of 24 hrs. are hoisted from the comparatively shallow depth of 500 ft. It is not so much the rate of hoisting as the facilities for the rapid charging and discharging of the automatically-dumping skips which make this possible.

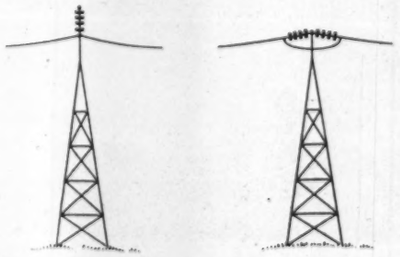


Fig. 3. A Possible Method of High Tension Line Support, Using Link Insulators.

The system of electric haulage is so worked, by short fast-running trains of mine cars, as to permit the introduction of capacious bins or ore-chutes from which the skips can be loaded rapidly by automatic lever-and-weight gear, while the loaded cars are also automatically tipped into the chutes by running them over a curved rail, placed at the angle necessary just to tip the loaded car, and then let it fall back into place after emptying.

The trains, composed of 6 or 8 cars, each of about 20 cu. ft. or one ton capacity, run at a speed of 15 miles an hour, even on curves of 55-ft. radius. The track is laid with 45-lb. steel rails, with manganese steel fittings, frogs and crossings. The locomotives resemble in appearance some types of racing automobiles, with broad, flat, beak-shaped ends; Mr. Rathbone states that they are made by the Westinghouse Brake Supply Co. The cost of this electric transportation, over a run of ½-mile, is given as 1½ d. (3 cts.) per long ton.

A system of endless-rope haulage, both on the surface and underground, is in use at the De Beers mines. There are from 50 to 60 miles of haulage cable throughout various parts of the works, with about 14,000 cars, principally for hauling the diamondiferous blue ground to the various floors, where it is left for eight or nine months to disintegrate.

When these cars arrive at the proper floors, which consist of many acres of flat, hard, prepared ground, they are dumped and their contents spread about in a layer about 2 ft. in depth, the blue ground being in more or less large lumps.

In the course of eight months or more the lumps, under the influence of air, rain and sun, crumble up into small stuff that can be readily shoveled up into cars for transportation to the washing machines. To hasten the disintegration process the mass of blue ground is harrowed over several times to expose fresh surfaces of the bigger lumps. Wheeled harrows, such as are used in farming, are drawn by traction engines over the floors. A small portion—say 5%—is not atmospherically disintegrated, and has to be broken by machinery.

Native shovellers load the disintegrated ground into cars, experts becoming able to load 40 and 50, and even 60, cars each in a shift of 8 hrs. The ordinary rate is 30 or 40 cars, paid for at the rate of 1½ d. per car-load of more than 20 cu. ft. The use of native labor, instead of mechanical means, in handling this disintegrated ground, is explained by Mr. Rathbone on the basis of the low cost of Kaffir labor against the high cost of coal.

The cars loaded with disintegrated blue ground are hauled by cable to the washing machines and discharged into hoppers, at the bottom of which are small revolving tables upon which the ground is divided and fed automatically into two revolving cylinders, so that the machines cannot become so overcharged as to cause loss of diamonds.

After leaving the automatic feeders the ground is mixed with "puddle" and a quantity of clear water is added. This mixture serves to bring the fresh supply of blue-ground in the pans to a proper consistency for washing, as experience has proven that diamonds and the heavy minerals associated with them separate from the mass of lighter material much better when mixed with a fairly thick "puddle" than in clear water. From the chutes below the feeders the mixture flows into a revolving cylinder, covered with steel plates perforated with 1¼-in. holes. All lumps larger than the holes pass out at the end of the cylinder and are conveyed to crushing rolls for further treatment.

The fine matter which passes the holes is fed into shallow, circular pans so divided as to form an annular space with 4 ft. between the outer and inner rims. Here the material is swept around by revolving arms carrying wedge-shaped teeth; the teeth are set to form a spiral, which forces the diamonds and other heavy minerals to the outer edge, while the lighter material flows out of the discharge opening in the inner rim. About 5 HP. are required to drive each machine; each will handle about 45 loads per hr., and uses about 50 gals. of water per load.

The concentrates from the washers are screened and taken to the pulsator house. There the sizes ⅛, 3/16, ¼, ⅜ and ⅝-in. are automatically fed on to selecting tables, somewhat on the order of our American Wilfley table. The table surfaces, about 8 × 3 ft., are divided into five steps, dropping about ½-in. at each step. The concentrates containing the diamonds, which include other heavy minerals such as olivine, garnets, iron, topaz, spar, etc., are fed to the tables very gradually, with an even flow of water. Each step division of a table has across it a series of slightly indented grooves which are filled with a grease somewhat of the consistency of vaseline. As the diamonds travel over these corrugated surfaces they are held by the grease, more than 95% of them being caught on the first step.

The only other substances arrested by the grease are nails and other objects of high specific gravity; the only other precious stone held is the ruby. The grease is collected intermittently and melted down to get the diamonds, of which the larger ones can be picked off by hand. The grease is used a dozen or more times.

All diamonds are taken direct to the Control Office of the Administration, in Kimberley, there to be carefully sorted and valued by experts, and all particulars noted in records.

Of every 12,000 loads (nearly 200,000 cu. ft.) of blue ground washed, the quantity of material, from a size of ⅝-in. downwards, reaching the sorters at Kimberley, does not exceed 1 cu. ft. Only 1% of the total amount of ground washed, or 1 in 100 loads, goes to the pulsator house as concentrates; about 8½% of this passes through the screens of less than ⅝-in. size, 33½% being above that size and the balance, 58%, flowing over the jigs as waste.

THE TURBINE LINER "LUSITANIA," recently launched by the Cunard Steamship Co., completed a 48-hr. continuous trial run over a 300-mile course, on Aug. 1, covering 1,200 miles at an average speed of more than 25¼ knots (29.1 miles) per hour with wind and tide partly against and partly favoring her. This record is favorable, from the point of speed, to the use of turbines for large vessels. Naval and shipping men, however, are awaiting the results shown in the coming transatlantic voyage of the liner; for the matter of economy in coal consumption, as compared with that where reciprocating engines are used, is still an open question. The War Department, on Aug. 2, authorized the use of the new Ambrose Channel by the big liner when she reaches the port of New York, about the middle of September. By that time the engineers in charge of the work expect to have the new course buoyed.

A DESTRUCTIVE BLAST.

A blast caused the destruction of a bridge and loaded freight train and the death of three men, near Chattanooga, Tenn., on May 16, 1907. The blast and its disastrous effect has been described by Mr. Hunter McDonald, M. Am. Soc. C. E., in a paper read before the Engineering Association of the South, and reprinted in the Proceedings of the Association for April-June, 1907. The excessive damage was so largely due to coincidence and the wreckage of the bridge and train so complete that the incident is worthy of notice.

At Wauhatchie, about six miles from Chattanooga, there is a single track line owned by the Nashville, Chattanooga & St. Louis Ry. over which the very heavy traffic of the Queen & Crescent Route, the Southern Ry. and the owning line passes, the daily trains here sometimes reaching as high as 98. On account of this heavy service the Southern Ry. is constructing a new line which at the point where it crosses the Chattanooga River, just emerges from a tunnel under Lookout Mountain. The present line crosses the river on a through Pratt truss bridge, consisting of one 102½-ft. span and one 151½-ft. span. Downstream from this bridge a pile-driver was working on a trestle to be used in connection with a new yard at this point and up-stream a temporary trestle had already been built for construction purposes.

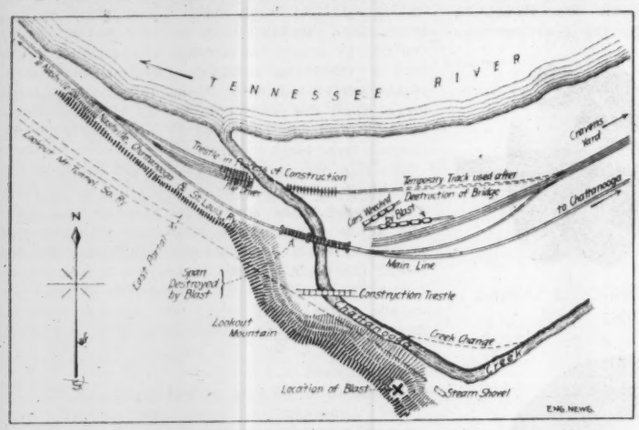


FIG. 1. MAP SHOWING LOCATION OF DESTRUCTIVE BLAST NEAR CHATTANOOGA, TENN.

On the morning of May 16, excavation was going on near the river bank on the Southern's new line at a point up-stream about 600 ft. from the permanent bridge. The material here was a hard clay, which was being broken up by blasting preliminary to removal by steam shovel. On account of the objections of nearby residents this blasting was being made in a few heavy shots, rather than frequent light shots. The first shot on this morning was rather heavily charged and lifted a large mass of the damp clay clear over the construction trestle and scattered it over the entire area between the permanent bridge and the trestle on which the pile-driver was working. Just at the moment of the blast a Southern Ry. freight train, with an engine and eleven cars, was crossing the permanent bridge eastward bound, with the locomotive about over the middle pier. The falling earth struck the bridge, which collapsed in some way, probably by breaking of the upper chords, and precipitated the train into the river, leaving the locomotive hanging to the pier, but totally wrecking the cars containing produce and cotton. Other parts of the material fell all around a mess-train, beyond the bridge, wrecking some of the cars and tearing up the surrounding ground.

An examination showed that most of the material was thrown about 600 ft., although some went as far as 900 ft. The material from the blast was entirely of damp clay; only one lump of stone from the blast could be found on the railway property. The accompanying map and half tone show the layout of the property and the complete destruction of the bridge span and train. The view (Fig. 2) was taken from the south side of the wrecked bridge, toward the pile-driver working on the trestle.

NOTES ON TAR MACADAM.*

By C. F. WIKE,† M. Inst. C. E.

Where paving is too expensive, perhaps the best material for minimizing dust is tar macadam, which is by no means a recent introduction, it having been adopted in some of the northern and midland towns for at least 30 or 40 years. In Sheffield it has certainly been laid nearly 40 years, and it is with regard to what has been done in this direction that the following detailed observations are offered.

At present there are 392 miles of roads, of which 241 miles are macadam roads; about 151 miles of the latter are repairable by the Highway Authorities, and, of these, nearly 10% are laid with tar macadam. The proportion may seem small, but the reason for this at once brings us face to face with one of the difficulties in the general adoption of tar macadam roads.

Many of the roads in the writer's charge have steep gradients, and no one who has had experience of tar macadam will suggest that it is a desirable material for hills. Up to the present a gradient of 1 in 20 has been considered sufficiently steep, and perhaps other engineers will be good enough to give their experience as to laying tar macadam on steeper gradients.

At one time most of this work was let by contract, and this is still the case to a limited extent; but about five years ago a plant was constructed by the corporation at an approximate cost of £1,000, consisting of sheds, iron-plated floors, with flues beneath for drying the broken stone, and heating apparatus for the tar compound. During the last three years the quantity of tar macadam prepared has averaged 2,300 [long] tons per annum, in addition to 900 [long] tons of tarred chippings for footpaths.

The specification to which the tar macadam is made is as follows:

1st Coat.—About 2 ins. in thickness of limestone "dark" in color, and of approved quality, sound, hard, and free from spar, and equal to sample. The stone to be broken uniformly to a 2¼-in. gage.

2d Coat.—About 1¼ ins. in thickness, of best slag, of sound, uniform material, free from honeycomb and dirt, from approved works, all equal to sample. The slag to be broken uniformly to a 1¾-in. gage.

3d Coat.—About ¾-in. in thickness, of slag shingle to a ¾-in. and ½-in. gage in equal proportions, free of dust, of the quality specified for the second coat, and equal to sample. The total thickness of the tarred material, after being rolled with the steam roller, to be 4 ins. and the top of its surface to be ¾-in. above the level of the channels.

After rolling the roadway is to be covered with a dressing coat of granite or limestone chips (½-in. dust out) of approved quality and thickness, as may be ordered, and again rolled.

The whole of the limestone and slag must be thoroughly well dried on hot plates; a mixture of pitch and tar must then be boiled in the following proportion: For the first and second coats, 108 [U. S.] gals. tar and 1[illegible] lbs. of pitch; and after boiling for two hours, 20 [U. S.] gals. of the mixture must be mixed with 3,360 lbs. of the broken limestone and 1¾ ins. slag.

For the third coat 17 [U. S.] gals. of the above mixture, after boiling, to be added to 1 cu. yd. of shingle.

The limestone and slag to be perfectly dry and warm at the time of mixing, and the whole thoroughly turned over, so that every part of the surface of the stones will receive a coating of the mixture. The above-mentioned porportions may vary according to the quality of the pitch and the strength of the tar. The prepared limestone and slag is then to be put in separate heaps, and left a sufficient time to toughen before being laid. After it has been properly toughened and freshened with a further quantity of pitch and tar (if considered requisite), it is then to be spread on the foundation in layers as specified.

The cost of slag and limestone tar macadam is about the same. If of the best quality, probably slag is the better material, and, in certain instances, it has been used for all three coats. The difficulty, however, is to get it sufficiently uniform and free from lime and other constituents which render it liable to early disintegration. This is one of its disadvantages as compared with limestone, which can be obtained of uniform hardness, and, as the use of tar macadam increases, so will the difficulty of getting sufficient slag of suitable quality increase.

Granite has not hitherto been looked upon as a suitable material for tar macadam, on account of its want of absorption. It was laid by the writer nearly twenty years ago in several streets, but, for the reason given, was not a success. It has recently been laid in some districts with tarred chips for binding, and similar work is in preparation in Sheffield. If the necessary adherence could be obtained, granite would, on account of its better wearing qualities, be more economical than either limestone or slag, and perhaps, with modern methods of re-tarring roads at frequent intervals, the old difficulty may be got over.

With regard to the cost of tar macadam roads compared with dry granite macadam, the initial cost is about the same, about 2s. 3d. to 2s. 6d. [55 to 60 cts.] per sq. yd., exclusive of foundation, the extra expense of tarring being balanced by the fact that a cheaper material is used than the granite macadam usually employed for important main roads, when these are not paved. Statistics have been prepared with regard to a typical suburban road, taking a considerable amount of traffic, and the annual charge [including initial cost] for a period of fourteen years has averaged about 4d. [8 cts.] per sq. yd.; this is for a fairly flat road. In another case—a road with light traffic—the average has been a little less than 2½d. [5 cts.] per square yard.

FIG. 2. BRIDGE WRECKED BY MATERIAL FROM BLAST NEAR CHATTANOOGA, TENN.

*Abstracts of remarks offered for discussion at a conference with delegates from local authorities, held in connection with the thirty-fourth annual meeting of the Incorporated Association of Municipal and County Engineers at Liverpool, June 20, 1907.

†City Surveyor, Sheffield.

If the best results are to be obtained, it is very advisable that after the first laying, tar macadam should be kept in thorough repair, and for many years it has been the practice to tar paint the surface at intervals of three or four years, or as soon as roughness begins to show. This has been done not so much with the idea of laying the dust as to prolong the life of the tar macadam.

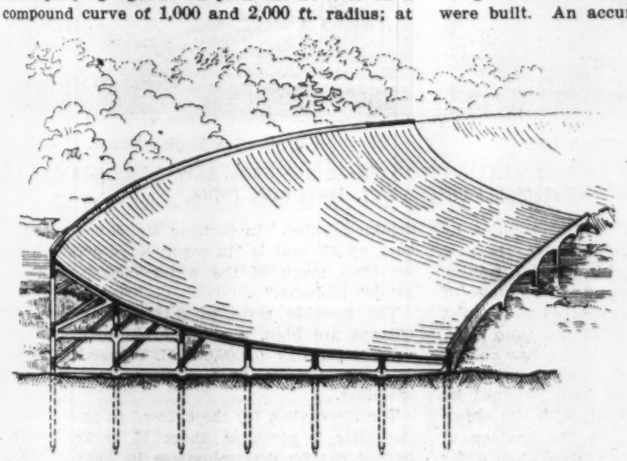
At present a considerable mileage of dry macadam road is being tar sprayed, and, so far as can be seen at present, it will be practicable to apply this system to gradients steeper than those upon which tar macadam has been laid. Nevertheless, there must be a limit to the gradients upon which tar can, in any form, safely be employed, as it is a material very susceptible to heat, and slippery in hot weather.

To sum up the writer's experience, tar macadam is a very suitable and economical material for many situations, and its use is bound to increase, but it has its restrictions, the principal one being that it cannot safely be used for roads with a considerable gradient. So far, the materials used have been inferior in durability to granite or whinstone, and therefore it has not been suitable for macadam roads with the heaviest traffic. The great advantages are the comparative absence of dust, and the quietness. Tar macadam roads are also economical in the matter of cleansing. The introduction of tar-spraying apparatus has materially helped to minimize the dust nuisance, and it is through the application of tar, in one form or another, that the nearest approach to a dustless road must be looked for, where paving (which, after all, creates the least dust) cannot be used.

A WARPED SURFACE REINFORCED CONCRETE BRIDGE.

The peculiar shape of a bridge built of reinforced concrete which has recently been completed in England makes its construction one of the noteworthy contributions to the progress of concrete bridge building. The structure forms part of the roadway of the automobile race course near Weybridge, England, where the 24-hour automobile record was recently broken. This course, about three miles in length, is an oval with two straightway tracks connected by banked curves. The straight roadways are founded on solid earth and are finished with a concrete surface. The bowl ends are built on earth fills, but a portion of one end is complicated by a small creek which must be spanned, necessitating a reinforced concrete column and beam construction.

A perspective view of this end is shown in the accompanying figure. In plan the bowl is on a compound curve of 1,000 and 2,000 ft. radius; at one end of the bridge, the outside elevation is 40 ft. above datum and the inside 12 ft. above; at the other end, the outside is 32 ft. and the inside 10 ft. 6 ins. above datum. The width at this point is 100 ft. and the total length of the bridge 200 ft. These dimensions taken in connection with the curved slope to the incline indicate what an extremely warped surface the track at this point assumes.



REINFORCED-CONCRETE BRIDGE ON BANKED CURVE AT BROOKLANDS MOTOR TRACK, WEYBRIDGE, ENGLAND.

The bridge was founded on concrete piles, some 14 ins. square and cut off just above surface level, at which point they were joined to columns molded monolithically into the heads of the piles. These columns were braced and counter braced by diagonal and horizontal beams and joined at their tops both longitudinally and transversely by main beams set at varying angles with the horizontal and having curved upper surfaces so as to provide support for the concave road slabs. These slabs are set in panels about 17½ ft. square and vary from 4½ to 6 ins. in thickness.

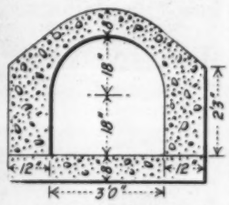
Abutments are provided at both river banks by vertical slabs extending between columns from the ground to the under side of the road slabs by means of which the earth fill that is under the main roadway is held back. Wing walls, not shown in the sketch, extend out both sides of each abutment.

The entire construction was erected under the Hennebique patents by the English branch of that concern. We are indebted for the sketch and the larger part of the information to "Concrete and Constructional Engineering" of London.

COST OF SMALL CONCRETE CULVERTS.*

By ALEX. R. HOLLIDAY,† Assoc. M. Am. Soc. C. E.

During the fall of 1904 the Pennsylvania Lines constructed a number of small concrete culverts on a coal branch in southern Indiana. Originally it had been planned to use 24-in. cast iron for the opening, using two where necessary, as the character of the country did not permit hauling heavier pieces. The plan, however, was changed and concrete substituted to facilitate construction and cheapen the cost.



Section Through Small Concrete Culvert in Use on Pennsylvania R. R.

The section in the accompanying figure was adopted for all openings, and the distance from spring line to pavement varied to suit the waterway. In most cases, however, this distance was made 18 ins. This section was used on comparatively poor foundations with fills as high as 10 ft. above the arch. Although the section is light compared to general railroad practice, yet none of the culverts shows cracks after being in over two years.

Eight culverts with a total length of 306 ft. were built. An accurate cost of the work was kept, the details of which are shown in the table below.

Crushed stone with screenings was used. The costs include an average haul of one mile in wagons from cars to the work. The ends were finished with a small spandrel wall. The cost per lineal foot includes the cost of these spandrel walls.

A comparison of the above cost with cast-iron pipe brings out several interesting features. At this time pipe was selling for $29 per ton f. o. b. foundry. As the standard 36-in. diameter cast-iron pipe, having a slightly less waterway than the concrete section used, weighs 450 lbs. per ft., it would have cost $6.75 per ft. at the foundry and would have totaled about $9 per ft. in place, including freight, hauling and placing. To provide the same waterway in 24-in. pipe as was required in this case would have cost still more. The concrete section cost therefore less than one-third of the cost of the cast-iron section. At the price given for cast iron and for cost of freight and placing the concrete section cost about the same per lineal ft. as 18-in. cast-iron pipe and provided four and one-half times the waterway.

In the two following seasons the same concrete section was used extensively and the unit costs materially reduced where the work was in proximity to the railroad. In one long culvert on marshy ground, under a 30-ft. fill cracks have developed along the center line at the top of the paving. Evidently the paving was forced to act as a beam on the soft ground. In cases of this character, a small amount of reinforcement should be used to take care of this beam action.

*In Engineering News, Dec. 20, 1906, p. 650, is an abstract of a paper by Mr. O. P. Chamberlain on the cost of concrete culverts, and also on the comparative cost of concrete and cast iron for small culverts.

†805 Traction Terminal Bldg., Indianapolis, Ind.

COST OF SMALL CONCRETE CULVERTS.

	Cost per lin. ft.	Cost per cu. ft.	Total cost.
Labor	$1.45	$3.35	$443.14
Stone and screenings, at 50 cts. per yd.	.25	.60	78.50
Cement, at $1.97 per bbl.	1.01	2.34	307.53
Forms	.04	.09	12.00
Total	$2.75	$6.40	$841.17

REPAIRING A BROKEN BRIDGE PIER was successfully done recently on the Kiel (Kaiser-Wilhelm) Canal in Germany. An abutment or rest pier of a railway swing-bridge at Osterrönfeld was struck by an 8,000-ton ore steamer, and the upper part of the pier was displaced. The pier is 30 ft. long and 16½ ft. wide, with rounded ends. Examination by divers showed a large crack, substantially horizontal, at a level about 10 ft. below water. This crack was about 3 ins. wide at one end of the river face, and 5 ins. at the other; but near this latter end of the face there were just above it two other parallel cracks 4 and 6 ins. wide, spaced 12 and 30 ins. above the main crack, and the intervening masonry was badly broken up. The crack disappeared a little beyond the middle of the rounded ends of the pier. Near one end it slanted downward to a level some 5 ft. lower. The endwise displacement of the upper or severed part of the pier was about 12 ins., and the lateral displacement, at one end, somewhat less, while at the other end there was no lateral displacement, the pier thus being partly turned on a vertical axis. The upward displacement of the bridge seat was about 7 ins. at one end and 2½ ins. at the other end of the pier. To repair the damage it was decided to leave the pier in its new position, merely shifting the bridge bearings to correct elevation and alinement, and to inject cement grout into the cracks so as to restore the continuity and strength of the masonry. For this purpose the crack was closed off very carefully by divers with wooden wedges and oakum. In addition a strip of canvas, 5 ft. wide, stiffened with vertical studs 10 ins. apart, was laid around the cracked part of the pier and tied down by chains and by top and bottom steel hoops, with turnbuckles passing around the pier; the studs were sawn through where the masonry was offset at the crack. At nine points in the packing, sections of 1½-in. pipe passing through into the hollow of the crack were fitted into the packing, and vertical risers going above water level were connected to these by elbows. Meanwhile a grouting apparatus was assembled on two scows. Its essential parts were: a compressor, delivering air at 120 to 150 lbs. per sq. in.; a receiver of 10 cu. ft. capacity, fitted with a controllable reducing valve on the discharge nipple; and three grouting drums, each of 2½ cu. ft. capacity, whose inlet was connected by hose with the receiver discharge. Each grouting drum contained a stirrer turned by hand. The delivery or grouting hose could be attached to any one of the three discharges. The mortar was a 1:1 mixture, mixed dry on shore, wheeled to the scow and there mixed in barrels with an equal volume of water before being poured into the drums. The grouting was done in one continuous operation, beginning at 7.30 a. m., and was finished at 9 p. m. the same day; 495 cu. ft. or 18 cu. yds. of grout were injected. The several grouting pipes were taken in succession, beginning with the one near the lowest portion of the crack, and using for each a pressure up to 60 lbs. per sq. in. At the end of the work all the riser pipes contained grout, so that there was reasonable certainty that the grout had entered and filled all voids in the masonry. The time to be allowed for undisturbed setting, during which time no further work was to be done on the pier, was doubtful, as the canal carries salt water. Two canvas-lined boxes were therefore filled with grout on the day the work was done, and lowered into the water alongside the pier; samples were taken from these boxes after 2 and 4 weeks and tested, and occasional drilling tests were made on the cement at the face of the crack in the pier. Five weeks after grouting, a load test was made (the bed-plates having been shifted to their new positions before the grouting), and traffic was resumed on Oct. 25, 1906. No signs of weakness have since appeared. The cost of these repairs was about $3,000, of which about $2,200 is chargeable to the calking and grouting operations. The work is described in the "Zentralblatt der Bauverwaltung" of June 29, 1907.

SEWAGE EXPERIMENTS AT MATUNGA, BOMBAY.

By GILBERT J. FOWLER,* D. Sc., F. I. C.

On returning from a period of work in India, the writer had the pleasure of visiting the sewage experiment station at the Leper Colony at Matunga, near Bombay, where for more than ten years valuable experiments have been carried on by Mr. C. C. James, M. Inst. C. E., recently sanitary engineer to the Bombay municipality.

These experiments are described in Mr. James's "Drainage Problems of the East" and the personal recollections which form the basis of this article have been supplemented by reference to that work. [The book was reviewed in our Engineering Literature Supplement for June 13, 1907.—Ed.] The photographs used in illustrating this article were taken by the present writer on the occasion of his visit.

The experiments originated through failure to purify the sewage satisfactorily and without nuisance, by direct application to land.

It is of interest to note that Mr. James constructed a tank at Matunga on similar lines to the Exeter septic tank, independently of Mr. Cameron. He prefers, however, to call it a "liquefying tank." The effluent from the tank is passed over land planted to maize, the height of which is appreciably greater at the point where the effluent first passes on to the land. The main crops grown are maize, guinea grass and jowar (millet). The financial returns have been increasingly satisfactory, the net profit in 1904-5 having reached 45% on the capital outlay.

Careful experiment has shown that sugar cane can quite well be grown with no other manure than the effluent from the liquefying tank.

The work which can be done by a liquefying tank in India is phenomenal and is an excellent instance of the difference in result which is brought about by differences in local conditions. A paper† has recently been published by Dr. Dzierzgowski, describing careful experiments made with domestic sewage from the Czar's Palace at Tsarskoe Selo, near St. Petersburg, from which the conclusion is drawn that the liquefying action of the tank, and also the amount of gas given off, are negligible. In contrast, at Matunga (and the experience here is quite borne out by the writer's own work in India), the deposit in the tank needs only partially to be removed at the end of three years, and an effluent is obtained nearly free from visible solids during most of that time. At the same time large volumes of combustible gas are evolved, which can be collected and utilized. The contrast is undoubtedly mainly due to temperature difference. In St. Petersburg the temperature seldom rose above 63° F., while in Bombay the average temperature of the sewage is from 78° to 90° F.

This effect of temperature doubtless may account for the very different results, as regards the efficiency of liquefying or septic tanks, reported from different places. It is a matter to be carefully borne in mind in designing works in different parts of the American continent.

Mr. James has made a special study of the conditions of evolution of "tank-gas," as he suggests this gas should be called. The quality and quantity of the gas appears to depend on: (1) Quality of sewage; (2) pressure at which gas is drawn off; (3) temperature; (4) velocity of sewage and disturbance of sediment.

In regard to the first point it has been found that a certain minimum dilution, at least 5 Imp. gals. per head, is requisite for the best results. Trade-refuse has often an inhibiting effect, and a preliminary inoculation with sediment from an active tank sets up the action much more quickly and satisfactorily than if the fermentation is allowed to develop spontaneously.

It has been further found that if the pressure is allowed to accumulate in a covered tank CO_2 is absorbed by the sewage and purification is not so rapid or complete.

*Broad Oak, Urmston, near Manchester, England. Dr. Fowler is now Consulting Chemist to the Rivers Committee of the Manchester Corporation. The Manchester Sewage Works are under the direction of this committee. Dr. Fowler was formerly chemist and virtually superintendent of the works, and is still ultimately responsible for their management, although relieved of detail in order that he may have opportunity for private work.

†Gesundheits Ingenieur, pp. 261-277, 1907.

The effect of temperature has already been spoken of. There can be little doubt that the gas, consisting as it does largely of CH_4 and CO_2, is chiefly derived from the fermentation of cellulose, and Omeliansky's work* has shown that this is due to two organisms, one producing methane and CO_2; the other, hydrogen and CO_2; the optimum temperature for the hydrogen bacillus being higher than for the other. The proportion of methane and hydrogen will therefore vary with the temperature.

The writer is at a loss to account for the rather large percentages of nitrogen often found at Matunga, occasionally over 60%. In numerous analyses of tank gas which he has made elsewhere, both in England and India, he has never found such large volumes of nitrogen. From the method of analysis given in the addendum to Chapter VI. in "Drainage Problems of the East," it would appear possible that sufficient oxygen was not always added to completely burn all the combustible gases, whose percentage would thus be decreased. In any event, the above-mentioned analyses have shown that if nitrogen is evolved at all it is mainly at the inlet to the tanks where there is the greatest amount of fresh foecal matter, and where, moreover, any nitrogen dissolved in the sewage would be first expelled by the fermentation gases. Experiments are now in progress at Matunga, with hopeful results, with the object of decreasing the percentage of nitrogen by taking off the gas evolved at the inlet end of the tank separately from the main bulk. The precentage of nitrogen naturally has an important bearing on the calorific value of the gas.

A rather curious result has been obtained by vigorously stirring the sediment, with the object of quickening fermentation, on the analogy of rousing yeast. More gas was evolved than under ordinary circumstances, but it contained a large excess of CO_2 and a deficiency of CH_4 and H, and was unsuitable for lighting and power purposes.

The views, Figs. 1 to 4, show the arrangements for collecting and purifying the gas. The liquefying tank is made gas tight by employing a sheet iron cover, carefully jointed and pitched, resting on a ledge some 9 ins. below the surface of the sewage, thus forming a water seal.

With a sewage flow from 430 persons at 30 Imp. gals. per head per day and a rest in the tank of 8 hrs., and with only two compartments of the tank covered in, a volume of gas varying according to temperature from 1,050 to 1,550 cu. ft. has been obtained. Mr. James considers that it would be quite safe to calculate upon an average volume of 3 to 4 cu. ft. of gas per head of population per day throughout the whole of the twelve months.

*Omeliansky Centralbl. Bakl., 1902 (ii), p. 193 and seq.

Before the gas can be used for power purposes the CO_2 must be removed by the lime purifiers, shown by Fig. 2. The gasholder is shown in Fig. 3. The gas is used to actuate a ½-HP. gas engine, to light the compound and building, and for cooking. The engine house is shown by Fig. 4.

The production and utilization of tank gas in quantity is the most novel feature of the Matunga installation, and corresponding space has therefore been devoted to it in this article.

Interesting work has at the same time been done with various types of filters. Fig. 5 shows a pair of contact beds for double contact. These have given good results with very little sign of clogging. Different types of percolating filters have also been used. Fig. 6 shows two experimental filter beds, fitted with a Stoddard [stationary] distributor and a rotary sprinkler, respectively. The effluent from the liquefying tank is of such high quality to begin with that very excellent filtrates are obtained, and only a practised eye can distinguish a sample from ordinary drinking water. In fact, as Mr. James remarks, such an effluent is "in many ways actually better than much of the water considered to be potable in India."

Fig. 1. Gas Tight Covers of Liquefying Tanks.

Fig. 2. Limé Purifiers for Tank Gas.

Fig. 3. Holder for Tank Gas.

Fig. 4. Gas Engine House.

FIGS. 1 TO 4. VIEWS OF INSTALLATION TO UTILIZE GAS FROM SEWAGE LIQUEFYING TANKS, AT THE LEPER COLONY, MATUNGA, INDIA.

The possible rates of filtration of the tank effluent are high, a rate of 440 Imp. gals. per sq. yd. per day (2,000,000 U. S. gals. per acre) being passed on to the filter by the rotary sprinkler.

The time taken for the effluent to pass through the filter is given at about 15 or 20 minutes. Recent careful determinations in England* have shown, however, that this short interval of passage only applies to a certain portion of the liquid passing through. The average velocity of the whole is in reality much less, certainly several hours being occupied before the whole of a given portion of sewage reaches the outlet of the filter. The rate of percolation is in fact a function of the total surface area of the particles composing the filter, and the amount of gelatinous and other matter on the surface of those particles. Thus, the same time is taken to pass through a small depth of fine material as to pass through a greater depth of the coarse material and the purification in the two cases may be the same, as certain ex-

*Recent paper by Mr. W. Gilford before Society of Chemical Industry.

periments by Mr. James himself have shown. This point is specially alluded to because the apparently rapid purification effected by percolating filters is frequently mentioned by Mr. James in his book, and his opinion appears to be shared by many engineers.

In addition to the experiments referred to, very good results have been obtained by the direct application of raw sewage to a Ducat filter. These results are valuable as showing that preliminary anaerobic treatment is not *essential* for the purification of even fairly concentrated Indian sewage. In certain cases, especially for temporary requirements, such as those of camps, a filter of the type of a Ducat filter may be more readily constructed than a watertight liquefying tank of concrete.

Altogether, the work at Matunga has undoubtedly brought out certain essential facts in connection with the treatment of sewage under tropical conditions. The difficulties which arise with increased concentration of the sewage, the limitation of treatment area, and the possible pollution of streams, by the effluent produced, were among the subjects of recent researches by the present writer, which will be published in due course.

THE FIRST CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY.

The Illuminating Engineering Society, after having been organized about a year and a half, held its first annual convention at Boston last week. The membership of the society is nearly 1,050, and there were over 125 members and guests registered at the Boston meeting. The professional sessions of the convention were held in the Boston Edison Illuminating Co.'s new building, July 30 and 31.

The entertainment features were largely merged with the "Boston Old Home Week" festivities. A shore dinner was served at Nantasket Point,

Fig. 5. Double Contact Beds.

Fig. 6. Percolating Filters.

FIGS. 5 AND 6. EXPERIMENTAL SEWAGE FILTERS USED AT LEPER COLONY, MATUNGA, INDIA.

and the members and guests spent the same evening as the guests of one of Nantasket's amusement parks.

The presidential address, "The Concepts and Terminology of Illuminating Engineering," was given by Clayton H. Sharp, of the Electrical Testing Laboratories, New York City. In opening Mr. Sharp stated:

> In the infancy of a science the concepts regarding it are necessarily neither very clear nor definite. The terminology of a science always lags far behind the actual state of the science itself. We must have the thing before we have a name for it—we must have the concept before we have a word to express it. An exact terminology, as contrasted with a loose one, is found to be more and more essential in proportion as its concepts develop and as the science itself progresses in exactitude. As long as the treatment of the science is qualitative only, no particular need is felt for an exact terminology. As, however, the science becomes quantitative and involves exact measurements of the quantities entering into it, the need for a terminology which is correspondingly precise is felt.

The author contended that the art and science of optics is in an elementary state so far as the concepts of light as a product for illumination purposes is concerned. It was stated that intensity of source and intensity of illumination are chiefly dealt with, and that there is no well-formed concept of a train or flow of light waves, which flow, for uniformity with other branches of physical science, might well be termed "flux." It was urged that the concept should be formed of all sources of light as generators of a flux, of all spaces surrounding the source as being traversed by this flux, and of all obstructing surfaces as receiving such flux. Certain definitions were drawn from this concept: the output of a light source is measured by the total luminous flux emitted; the brightness of a diffusely reflecting or transmitting surface is proportional to the flux emitted per unit area, and its reflecting or transmitting coefficient is the ratio of flux received to flux emitted; the intensity of illumination on any surface is the flux received per unit area. A unit in terms of which luminous flux may be measured was defined similar to one in magnetism and electro-statics; that is, unit flux is emitted by a light of "unit intensity," in a unit solid angle. As there are 4π such solid angles, the approximate relation was developed that a unit angle was the one subtended at a point by a surface of one linear unit squared and one linear unit distant. If at the apex of such an angle a source of one "unit intensity" exists then a unit flux will fall on any plane traversing the angle, no matter how far the plane is from the apex or at what inclination to the path of the waves. The unit of flux depends on the chosen "unit of intensity," according to the author of this paper, and the adoption of an already suggested term was urged. This term is the "lumen," and by it is meant the flux emitted by a source of 1 c. p. through a solid angle. It was shown that lumens divided by area, in feet, gave foot-candles; divided by meters gave the illumination intensity in "lux" (candle-meters). Attention was directed to another point in terminology; the present uses of the word "efficiency." Three uses in illumination work were taken up: (1) The efficiency of the lamp, now expressed in watts per c. p. (which is really specific consumption). This efficiency could be denoted by lumens per watt. (2) The net efficiency of the whole installation, which is the problem of the illuminating engineer; given any illuminants whatever to find that way to equip and arrange them so as to produce the maximum illumination. Such an efficiency might well be expressed by the ratio of lumens received, on a horizontal plane of reference, to the total flux of the lamps. (3) Gross efficiency, which was well expressed in terms of lumens on the horizontal reference plane per watt (with electric power) or per cu. ft. per hr. (with gas). The need of such a term has been shown by the use of the awkward "foot-candles per watt per sq. ft." This analyzed means quantity of light per watt, or "lumens per watt." Here the concept of flux and the term lumen have simplified a cumbersome and complex expression to one of greatest simplicity.

Edward P. Hyde, of the National Bureau of Standards, Washington, D. C., in a paper entitled "Primary, Secondary and Working Standards of Light," outlined the familiar scheme of having as primary standards, those light sources reproducable from written specifications; as secondary standards, those which, once calibrated from the primaries, would remain constant, though not themselves exactly reproducable; as working standards those similar to the secondary standards and whose constancy under service may be easily checked. For the photometric comparison of flame illuminants, a flame working-standard, calibrated under normal atmospheric conditions, was stated to be advocated by many gas-engineers. The reason for this was said to lie in the same relative changes under abnormal atmospheric conditions of both the standard and the illuminant to be compared, resulting in a just photometric comparison. The adoption of an "international candle" as the unit of "intensity" was advocated, to eliminate present discrepancies in the ratios between English candles, Hefner units, and bougies.

Mr. L. H. Scherck, of New York City, read a paper bearing the title "Illuminating Engineering and Central Station Practice." In this central station engineers were advised to study the use of energy consuming devices on their own systems and to be illuminating engineers to the extent that they could stop customers' excessive bills in wasteful lighting schemes.

"The Illumination of the Engineering Societies Building," New York City, was described in a paper prepared by C. E. Knox, Consulting Engineer, New York City, and read by F. R. Nugent, of New York City. The general architectural features were briefly outlined, as were the relations between the engineers and the architects in providing the illumination.*

The problem of lighting the auditorium which occupies the larger portion of the 3d and 4th floors was the most difficult and interesting one of the whole building. At the outset it was sought to overcome the common defect of most large rooms where the sources of light comes in the field of vision. A plan was evolved in which the sources were entirely screened by placing behind special glass panels forming a part of the ceiling design. To obtain access above the glass ceiling for relamping and cleaning, the ventilating engineer and the architects arranged to provide entrances through the ventilating ducts in the false ceiling serving to exhaust the air from the auditorium. The maximum distance from the top of the glass panel to the bottom of the floor was 17 ins., and owing to this limited space, the types of lamps were limited and reflector incandescent lamps were adopted as being the shallowest on the market, fairly efficient and requiring no reflector.

The daylight illumination of the library was obtained from skylights and it was decided to use the kind of glass employed in the auditorium panels, and so place the lamps above the skylight that they would cast no shadow in the daytime. The alcoves were lighted by means of special 18-in. glass globes, supported by chains from the ceiling. The globes are of a special light opal glass, slightly ground inside, yielding a pleasant glow. The value of the services of an illuminating engineer here were shown clearly in the savings of the fixture contract. The architect's preliminary figure was $30,000. The consulting engineer's preliminary figure was $20,000, and the actual contract was under $10,000. A considerable portion of the paper was taken up by results of tests of the actual illumination.

"The Present Status of Candle Power Standards for Gas" was the title of a paper presented by C. H. Stone, of the (late) New York Commission on Gas and Electricity, Albany, N. Y. When, after the introduction of the Welsbach burner, the gas companies reduced the candle power of the gas many consumers felt that they were being defrauded. In defense of the reduced candle power it has been said that the greater part of the gas made today is burned in Welsbach burners and in stoves. In both cases the candle power of the gas as burned in an open flame does not enter. The author made investigations in Brooklyn and in various cities and towns of New York State and found the proportion of Welsbach and open burners very much less than generally supposed. He stated that it was only on account of those consumers using common burners that a candle power standard of gas was of any use, and if gas is tested at all it must be to see that those using ordinary burners receive adequate light.

After quoting a large number of instances where high candle power standards had been

*See Engineering News of Jan. 3 and April 25, 1907, for description and illustrations of building.

fixed and easily maintained by the gas companies, it was stated that the most desirable thing to do would be to drop candle power standards and adopt one of heat units.

"The Inverted Gas Light" was presented by T. J. Little, Jr., of the Welsbach Co., Gloucester, N. J. The American form of inverted burner was sketched.* It was stated that the question always arose as to why the inverted gas light was more efficient than an upright. With the upright form the products of combustion must pass through the mantle, while in the inverted, the mantle largely baffles the gases from the burner tip, which pass out between tip base and mantle, allowing free access of air to the surface, attaining a more complete combustion and consequent higher temperature at the mantle surface.

It was stated that with the upright burner the scientific adaptation of the prismatic reflectors used in electric lighting was not possible. Light was necessarily wasted in being thrown to the ceiling.

In the discussion of this paper V. R. Lansingh stated that tests have shown the combined effect of inverted mantle burners and proper prismatic reflectors was to increase the effective illumination, on a plane below the lamp, about 34%.

Mr. Nelson Goodyear, in a paper on "Acetylene Lighting," state that the cost of acetylene gas, when carbide is at $3.75 at the door of consumer, is about 69 to 83 cts. per 1,000 cu. ft., not including charges for depreciation, interest or repairs. In dealing with the safety of acetylene, Mr. Goodyear quoted George Gilbert Pond (Bulletin 57, Department of Agriculture of Pennsylvania). This bulletin divides the risks into three sections: toxic, vitiating the atmosphere, and danger of explosions. A 5,000 light installation at the Grand Union Hotel, Saratoga, N. Y., was shown as typical of recent progress. Forty requirements for a good stationary generator were given in an appendix to the paper.

"Illumination Photometers and Their Use" was the title of a paper by Preston S. Millar, of the Electrical Testing Laboratories, New York City. The paper was largely a comparison and description of several commercial illumination photometers, with a discussion of what characteristics a successful photometer should have. Only such instruments were included as depended upon visual acuity in detecting the vanishing point of an effect produced by the light to be studied, either by the disappearance of a figure or of a contrast. It was stated that the only photometers which might be relied on for engineering work were those in which a comparison light source is used, and the eye relied upon to judge the equality of illumination.

Mr. Millar also presented a paper on "The Elements of Inefficiency in Diffused Lighting Systems." He discussed the elements of inefficiency for any system where the lighting of the walls and ceiling was more than incidental. His conclusions were based on certain measurements made on a temporary equipment at the Electrical Testing Laboratories. The first factor considered was the absorption by walls and ceiling; the tests outlined gave this reduction as 50-70%. The second factor was the necessity of having at unimportant points an illumination of nearly the maximum of important points. For instance, in providing a definite reading illumination for a page held at an angle of 45° to the vertical, with diffused lighting it is necessary that this desired flux of light should fall on the page, irrespective of the direction in which the page is turned. When direct lighting is used the reader disposes himself most favorably towards the sources, and it is necessary to provide the desired illumination only for such a position of the reader.

With diffused lighting the body and nearby objects obstruct as much as 10% of the light which would otherwise be effective.

The last factor considered the need of greater illumination to accommodate the eye when contrasts are eliminated. We quote directly from the paper on this point:

> It was found that if a placard was viewed at a distance of 8 or 10 ft., thirty times as much light was required to enable an observer to read it as well with the diffused lighting as with the direct lighting arrangement. In this test large portions of the walls were within the angle of vision, and exercised a powerful influence upon the eyes of the observer with both lighting systems. With the direct lighting system the walls were relatively dark, influencing the pupilary action of the eye so that a low intensity upon the placard appeared satisfactory. With the diffused lighting system they were brilliantly illuminated and so affected the eye that a very intense illumination was required upon the placard.
>
> From the foregoing, the writer has drawn the following conclusions: In diffused lighting systems of the class considered, where the illumination of a working plane is one of the prime objects, a large proportion of the light is lost; that which is not lost becomes less effective; brilliant illumination is produced where it is useless and even undesirable; and conditions are established which create a demand for an unduly high intensity of illumination on objects viewed.
>
> These effects are present in varying degree in all systems in which control of any large proportion of the light is lost. Among such are cove lighting, lighting with skylight effects, tube lighting, and all systems in which the brilliancy of the light source is reduced by diffusing surfaces used without any directing adjuncts. Lighting with large sources is more liable to these effects than lighting with small sources.
>
> The facts indicate the need for devoting as much care to securing suitable minimum intensities, as is generally expended in striving for maximum values. In certain classes of lighting where more light is asked for, the requirements may be served by reducing the intensity of illumination on unimportant objects which are unnecessarily well illuminated. By taking advantage of opportunities to minimize intensities at unimportant places efficiency is gained, and, in the opinion of many, good lighting as well.

In "Electric Light as Related to Architecture," Mr. C. Howard Walker, of Boston, Mass., gave an interesting exposition of the difference in the principles of daylight and artificial light effects in architectural design, beyond merely having necessary amounts of illumination for definite utilitarian purposes.

It was stated that architectural effects in artificial lighting depended upon the use of lighted areas rather than the shadows of daylight, and that the charm of architectural effects under artificial light was one of eery lightness in contrast to the solidity of the structure by daylight. Mr. Walker contended that the greatest care and cooperation was necessary to prevent entirely destroying interior architectural effects of strength, and that the architect should decide what could not enter the design in that respect. An instance was the cove lighting scheme in the auditorium of the Edison Illuminating Co.'s Building, Boston, Mass., the room in which the session was being held. The ceiling beams were supported by pillars with a cove at the junction of beam and ceiling. Lights were installed in the cove, but when used caused the beam effect to disappear, so that the ceiling seemed to have no connection to the row of massive pillars supporting a very light board. "Exposition lighting" and outlining buildings was stated to be merely a case of drawing in coarse chalk lines on a blackboard. With most buildings and groups of buildings the important horizontal lines are to be accentuated if any effect at all of perspective is to be maintained. The introduction of vertical lines causes the perspective to "shut up," and should be used only where it was desired to isolate a building or outline a tower. The reason for this effect lies in the fact that with several lines of open lights distant from the spectator by amounts varying several hundred feet, the more distant ones appear equally near.

"The Lighting of the Boston Edison Building" was described in a paper by Messrs. Louis Bell, L. B. Marks and W. D'A. Ryan. In treating the exterior, every effort was made for harmony with the architectural design. Such a building needs considerably more illumination, both outside and inside, than would be ordinarily expected with any other. The first floor exterior was made very brilliant to attract attention to the display rooms. The balcony above was dimly lighted by reflected light. The upper stories were indicated by cross bands at the cornice and other important architectural points. These bands drew the apparent height of the building down and eliminated the dark, towering effects otherwise obtained. Throughout the interior it was desired to obtain the best of illumination effects, illustrating as far as possible the various ways and means now open to the engineer. There are no brilliant sources in the line of vision anywhere in the building. The intensity of illumination throughout was stated to be about two or three candle-feet. In the exhibition room it rises to about four.

The same author presented a paper on "Coefficients of Diffused Reflection." This was based on the results of tests made on actual wall papers of various color, texture and finish, with an idea of closely following actual practice and of checking data already derived or deduced.* With wall papers of a faint cream tint, Dr. Ives obtained the highest reflection coefficient of 0.61. Light creams and yellows followed with 0.60, roughly. Then came gray, yellow, light red, pink and lilac, with 0.40 to 0.20. The fashionable papers of dark tones yielded values as low as 0.05. Little difference was shown by texture. The angles of incidence of light rays in these experiments were between 30 and 40°.

A paper, "New Lights and New Illuminants from the Central Station's Point of View," was presented by Mr. R. S. Hale, of Boston, Mass. The central station was defined as the intermediary between inventor and customer. When the central station company does not handle the lights in any way, the author stated, it might regard new lights as of such increased efficiency as to cut down the necessary output or to cause a greater demand for electric lighting, so as to increase actual sales. If, on the other hand, the company supplies lamps and includes the cost in the rates for current, it was stated that the company may not merely wait to see what is the outcome. If the company adopts the new illuminants, the immediate effect, as described, would be to give the customers more light for their money. This may cause an immediate drop of income, followed probably by a heavy increase. The company may use its influence so that from the start the sales of current remain the same with a greater increase in the light received by the customer.

It was stated that a curious condition existed among the customers of lighting concerns. It was found in putting out tantalum lamps that the customer objected to paying occasional renewal charges of 30 or 60 cts. much more than he objected to paying 60 cts. or $1 every month for extra current.

A question, stated as affecting the central station people, was that of deliveries of new lamps. The author contended that it would be several years before all carbon filament lamps in the sizes practicable for "Gem" filaments would be so equipped. The question was stated to have arisen as to who shall receive the limited supply, without discriminating against customers. Some companies were described as having placed a small renewal charge on such units. The central station people might pick out classes, such as churches, municipal buildings, stores, and finally residences, for the free renewals of higher efficiency lamps as the supply increases. In conclusion, Mr. Hale summarized the situation concisely:

> These difficulties always arise when any new invention is made. If the customer supplies the lamps, as he does the fixtures, then the customer has the difficulties, and the central station waits for the final result, which may be either more business or less business. If, however, the central station supplies the lamps, it must handle the question so as to give as small a temporary loss of income as is possible, and so as to get the final result from the new illuminant as quickly as possible.
>
> If any one doubts the wisdom of having a central station try to handle all these difficulties of illumination and lamps and candle-power, etc., all that is necessary is to ask such person to look at the results in countries where the central station confines itself solely to the supply of electricity, and leaves the question of lamps and illumination to be handled by the individual customers.

Mr. W. H. Blood, Jr., in a paper entitled "What is Street Lighting," traced the chronological development of street lighting, and laid down three results to be obtained: crime prevention, street ornamentation and increased facility of traffic.

"The Metallic Flame Arc Lamp," by Mr. C. E. Stephens, of Pittsburg, Pa., was a comparison of the results of two methods of constructing a magnetite arc lamp, one with the positive electrode above the negative, one with this relative position reversed. A discussion of some general requirements of both systems was also included.

*This was described in Engineering News, issue of July 25, 1907.

(*Tables derived from a variety of sources have appeared at various times. One such was given in Eng. News, July 25, 1907, p. 99.)

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Two features of a septic tank installation near Bombay, India, described by Dr. Gilbert J. Fowler, elsewhere in this issue, deserve special attention. One is the marked septic activity and small sludge residue under a uniformly high temperature and the other is the large volume of gas produced by the tank and its utilization for power, lighting and cooking. While records of septic tank installations in the southern and warmer parts of the United States are very meager, statements brought to our attention indicate a lesser volume of sludge in the south, and particularly in the hot, dry southwest, than in the cooler northern sections of the country. Information on the relation of temperature extremes to sludge volume and gas production, drawn from actual installations the world over, would be welcome.

An unusual explanation for a derailment is given in the report on a recent Board of Trade investigation on a fatal British trolley-car accident. A double-deck single-truck car was derailed on a left-hand curve of 55 ft. radius located at the foot of a quarter mile of 3.6% grade. The car approached the curve at a fair speed; just before the curve the conductor had put on the hand brakes (from the rear platform) as hard as he could, so hard in fact that the wheels skidded, and the motorman's control by electric braking was therefore ineffective. The car was derailed after it was some distance on the curve, and overturned on its right-hand (outer) side, on the outside track. But the inspector of the Board of Trade does not believe that mere centrifugal force was sufficient to overturn it. He computes that, neglecting the shifting of the body due to spring compression, a speed of about 18 miles per hour would have been required to overturn the car loaded as this one was, and apparently he does not find sufficient reason for believing that its speed at the time of derailment was so great. He concludes, as to speed, that:

> The whole evidence, in my opinion, proves that the car traveled down Park Lane at a speed considerably in excess of the authorized limit—eight miles an hour. * * * I am persuaded * * * that when the car entered the curve its speed was considerably in excess of the three to five miles an hour estimated by both Woodley and Linney [the motorman and conductor]. It may easily have been as much as eight or ten miles an hour. But taking the whole evidence into account the speed must have been considerably less than that theoretically necessary to cause overturning by the effect of centrifugal force.

The inspector therefore assumes that the car was first derailed, and then, running over the pavement some distance, fell over on its side. There was no obstruction on the track, as far as discoverable. The theory is therefore advanced that the locking of the wheels by the brake was responsible for the derailment. This is set forth in the following terms:

> The wheels being unable to accommodate themselves to the change in direction, the flanges must, I think, have got jammed in the grooves, with the result that the truck came to a sudden stop as described by Woodley. The tendency of the heavily-loaded body would be to overrun the truck, and a severe lurch must have followed the sudden stoppage of the truck. All the live weight on the car must have swung outwards with the lurch, and, acting with the effect of centrifugal force, must have suddenly tilted the car so that, as it appears to me, the flanges lifted out of the grooves. The truck was then free to jump forward and skated on its outer wheels for 10 to 15 ft. The car was unable to recover its equilibrium owing to the probable displacement of the live load on the top deck, and fell over on its side, just as its inertia was exhausted.
>
> It can be shown by experiment that a vehicle with freely rolling wheels will travel safely round a curve, where proper superelevation is provided, but will, on the same curve and at the same speed, overturn, if the wheels are prevented from rolling, and thereby become track-bound.

Such a novel theory to account officially for a serious accident should, we think, not be stated without the accompaniment of a fuller proof or explanation. We are safe in saying that the "experiment" referred to is not sufficient to establish the theory, quite apart from the fact that the experiment is quoted as showing overturning (?) whereas the theory advanced charges that the wheels lifted out of the grooves. Further, some features of the "theory" are difficult to understand. If the lurch spoken of, cooperating with the centrifugal force, tilted the car, as alleged, then the outer wheels would certainly be less liable to jump from the rails than before. Moreover, while the truck was checking up in its forward motion, its centrifugal effect was decreasing proportionately to the square of the velocity. Why should the car tilt after the stopping of the truck if it did not do so before? Again, if the wheels were derailed and the car therefore free to move in a straight line, why should it skate along its outer wheels, instead of returning to an even keel as soon as released from the curve? Altogether, the "theory" is anything but an explanation of the accident; rather it leaves it more obscure than before.

There is, however, an action favorable to derailment, under the circumstances of this accident, and this is another reason why it is unfortunate that the faulty "theory" above quoted is put forth in such obscure shape. The flange friction of the front outer wheel of a car, when the wheels are free to roll, is produced by a rotative motion of the rubbing flange surface past the side of the tread. With wheels held by the brakes, this part of the flange surface must slide bodily along the rail head at the full speed of the car. Its retarding effect is much greater in the latter case, and there is a much increased tendency for the car to skew in the track and for the front outer wheel to mount the rail. In the present case this action must have been intensified by the fact that the car was top-heavy, the wheel-base very short—only 6 ft.—and therefore the concentration of load on the front wheels during the retardation unusually great, correspondingly increasing the flange friction.

While an action as just described is bound to occur in a case like that in question, it shares with the official "theory" the defect of not explaining the falling over of the car. The roughness of the pavement, or the jump caused when the inner wheels rolled over the outer rail, might account for this. But it is to be noted that the simple centrifugal explanation is not satisfactorily eliminated by the facts quoted in the report, especially as the tilting of the car on its springs has been neglected in computing the critical velocity, and the curve, which may have been eased from its average radius, may have been considerably sharper than stated in its middle portion.

A report of the first convention of one of the youngest engineering societies appears elsewhere in this issue. This meeting of the Illuminating Engineering Society was significant in several ways. The papers and discussions were such as to promote a fuller realization than has heretofore existed of the benefits that result from carefully planning any lighting scheme. Incidentally the economy of well-designed illumination, both in first cost and in operation, was demonstrated. For instance, the interesting statement was made, concerning the new Engineering Societies' Building in New York City, that the architect's first estimate of the cost of fixtures was about $30,000, while the actual contract as arranged by the lighting engineers was below $10,000. Nothing was sacrificed in the beauty and dignity of fixtures, while much was gained in desirable qualities of illumination. In the case of the Boston Edison Illuminating Company's new building, where there is a superabundance of light throughout, it was stated that the cost of lighting is scarcely more than for some dimly lighted office buildings of the same capacity.

Contrary to what might have been expected, this meeting was by no means an entirely electrical affair. The gas-lighting industry was well represented, and it was at once evident that the engineers of both the apparatus makers and the gas manufacturers are alert and quick to utilize every development which will increase the efficiency and add to the esthetic value of gas lighting in every form. If the development of high-efficiency electric incandescent lamps can be considered as a challenge to gas lighting, it is evident that the gas-engineers are concentrating their energies in developing successful competitors for the new lamps.

A fundamental concept of the science of illumination was discussed by Dr. C. H. Sharp in his Presidential Address, before the Boston Convention of the Illuminating Engineering Society, with an argument for the use of a term lately developed. The term "candle-power," now used to denote the unit of output of a light source, Dr. Shrap would largely replace by "lumen," the unit of light flux, which is the $\frac{1}{4\pi}$ part of one "mean spherical candle-power." The new idea appears clearly from Dr. Sharp's address:

> We should form a concept, then, of all sources of light, whether primary or secondary, as the starting points of a luminous flux, and of all spaces surrounding such sources of light as traversed by this luminous flux. Having formed the concept of luminous flux, the following definitions and relations are a direct consequence: The output of any lamp is measured by the total luminous flux which it emits; the brightness of a diffusely reflecting or transmitting surface is proportional to the luminous flux which it emits per unit of area; the reflecting or transmitting power of such a surface is the ratio of the luminous flux which it emits to that which it receives; the intensity of illumination on any surface is the flux which it receives per unit of area.

The words in which this concept is stated seem to impress one that a new physical quantity has been developed, which is by no means the case. The concept of flux has been vaguely understood, even when it is stated that candle-power means "intensity" of light source. What is really meant and generally understood, if the users of the term "candle-power" would ponder a few seconds, is relative quantity of light compared with that given off by a standard candle. The term "intrinsic brilliancy," as used to mean relative amount of light emitted per unit of apparently active area, is the logical expression for intensity, and "candle-power" is not. This distinction was not emphasized in the address quoted as strongly as it might have been, especially when it was said:

> It is necessary first to define a unit in terms of which luminous flux is to be measured and to establish its relation to the unit of luminous intensity, the candle-power. This is done in a way analogous to that employed in magnetism and electrostatics; that is, unit flux is defined as the flux emitted by a light of unit intensity, or one candle-power, in a unit solid angle.

In the preceding quotation there is a loose and confusing use of the word "light." This term should only be employed in describing the product of a lamp or a light-source and not as synonymous with "lamp" or "light-source." Dr. Sharp's meaning, both in respect to this term and to the idea of "candle-power" not indicating

intensity, would have been better expressed were the paragraph last quoted made to read:

> It is necessary first to define a unit in terms of which luminous flux is to be measured and to establish its relation to an arbitrary standard light source. This is done in a way analogous to that employed in magnetism and electrostatics; that is, unit flux is defined as the flux emitted by a unit standard source, or the standard candle, in a unit solid angle.

Such an arrangement of the text does not disturb the concept of luminous flux nor limit the utility of the term "lumen." It does emphasize, however, the fact that the unit of luminous flux is not related to the units of physical science, though derived in an analogous manner.

The concept and unit of luminous flux are of great value because of their analogy to the fundamental concepts and units of electricity and magnetism, and because, like them, this concept and unit are adaptable to important derived quantities with less chance of confusion than is the idea of "candle-power" with its associated indefiniteness. For instance, the lumens, falling on a surface divided by the area, gives simple intensity or flux density; lumens emitted by a lamp per unit of active area gives intrinsic brilliancy, and so on through the more complicated candle-power derivatives of the present time.

THE ARCHITECTURAL TREATMENT OF CONCRETE.

Concrete has scored a great success as a substitute for wood and steel and brick in building factories and mills. It is now desired to use it for a higher class of structures. Every architect of extensive practice is besieged, we are sure, with propositions from his clients to build dwelling houses, school houses, stores and other structures of concrete, and is obliged to explain repeatedly that excellent as concrete is structurally, the task of producing a surface of pleasing finish with it is one which he is not yet ready to undertake and guarantee results.

In the days when many of Europe's architectural monuments were erected, before any theory of the strength of materials had been made, and when no one thought of figuring out the stresses in a structure before building it, the architect and the engineer were combined in the same person. As the constructive arts developed, two separate sets of builders grew up; the engineer, who built for strength and utility; the architect, who built for beauty. In very recent years the differences and rivalries between the two professions have been diminishing, until they are now working in harmony, each a specialist in his own work, but each dependent on the other for the perfection of that work.

Concrete was primarily an engineer's material. So long as it was made with the lower grade natural cements and hydraulic limes, it remained in use exclusively by engineers. Even after the introduction of Portland cement there was little concrete used outside of engineering work for many years. The extensive use of concrete in buildings and the ventures in its use as an exterior finish unprotected by stone are matters of very recent times, practically coincident with the use of concrete and steel in combination.

In the endeavor to make the surface of this new material as attractive as possible, the mistake has been made of treating it to imitate stone. Even when cast as a monolith it has been cut up with surface lines to imitate masonry of separate blocks. Elaborately carved cornices have been cast in concrete; copings and gargoyles; griffins and pilasters; anything and everything that has been made in stone has been imitated in concrete, and the results have been generally disappointing.

The true architecture of concrete will come when imitation is abandoned; when it is recognized as a material capable of its own especial treatment for the production of artistic effects otherwise impossible. But such an architecture has not been developed. The most enthusiastic advocate of the modern concrete factory cannot call it beautiful; it does not need to be, for its wooden or steel predecessor was not beautiful. But before we can have concrete public buildings and private residences, or even bridges of a monumental nature, the material must progress in its artistic treatment far beyond where it now stands.

The architect, by virtue of his skill and training, is the only professional judge of the beautiful in construction. He is the only one to whom the future artistic development of concrete can be safely entrusted. There are engineers who are competent judges of esthetic design, but they are engineers with architectural ability. The concrete structure has reached a high degree of structural excellence; the engineer can turn it over to the architect for the treatment necessary to make the material fill the highest place.

Beauty in the design of concrete structures will only come when the architect abandons his prejudices against it and regards it impartially as a new material to be treated in a new way.

A good architect is an artist and to him as to Keats

> Beauty is truth, and truth beauty—that is all
> Ye know on earth, and all ye need to know.

It is his ideal—not always realized—to produce beautiful structures. From his limited knowledge of concrete and from the designs produced by past workers in it, it is an imitation. There is no truth in it; ergo there is no beauty in it. When he comes to realize that it is a material in itself and not an imitation; that of it structures can be built strong as any engineer of the oldest school could wish, nearly as cheap as some of its promoters now claim, and as beautiful, after its own individual style, as any masonry structure now standing; then and then only will be developed an architecture of concrete which will endure.

The efforts of all engineers who are interested in the future of concrete should be bent toward this end. The designers of concrete structures at the present day should abandon shams and deceptions and make the material stand forth as what it is. Imitation rock faces made with molded forms should be discarded; joints where no joints naturally come should be left out; intricate cornices should be done away with. Surface treatment is one of the main points to be studied. After one has seen the surfaces of the concrete bridges treated by the Quimby method around Philadelphia, he realizes the faults of the blistered and cracked finish of the average cement mortar face of ten years ago. The possibilities of color schemes in concrete have hardly been touched upon by anyone yet. It is worth a trip to Washington to see the magnificent effect of the grey granitic quoins against the yellowish main face of the new Connecticut Avenue bridge.

All these are merely hints of what the mind trained in artistic treatment can achieve if once the task is fairly attempted.

Beauty is not necessarily a matter of adornment. Neither is it necessarily a matter of strict adherence to ancient forms of architecture; the bold and striking lines of the Flatiron building as viewed from the north end of Madison Square are beautiful to all but the confirmed classicist. So will it be with concrete when the engineer has succeeded in persuading the architect or at least the architectural mind in his own profession that there is at hand a material strong and cheap, but at the same time capable of an independent treatment which will give it an individual style and a beauty different from that of any material heretofore at the architect's command.

LETTERS TO THE EDITOR.

The Tie Problem Solved but the Process a Secret.

Sir: Here sometime ago I was talking to Mr. Fish, who will in all probability be the next President of the Missouri Pacific Railway, I says the most serious problem before the Railways now is Railroad Ties,

Yes he says that is serious. But we have got that solved,

I says how have you done it; "He says it not finished yet; but nearly will be soon. I says how so: Why he says we have secretly in here been experimenting in Timber & we find that we can take old wore out ties & Timber & reduce it to a liquid Pulp & run it into molds & then by a chemical Process Make the finest kind of a Tie that we expect will last for years,

Your Truly Jack.

St. Louis, Mo., July 17, 1907.

[This letter is so interesting that we break our usual rule as to publishing anonymous communications.—Ed.]

Screw Pumps.

Sir: In your issue of July 18th in your review of Mr. C. B. Burdick's paper on "Methods of Pumping Deep Ground Water," it seems to me that the pumps shown in Figs. 1, 2 and 4 are erroneously described as "centrifugal," as they are really of the "screw" type.

While the application of this type of pump for deep-well work is of comparatively recent date, this form of pump itself is not new, having been built by Mr. Edwin Reynolds at least forty years ago. The most notable application by Mr. Reynolds was the Milwaukee flushing pump, which was designed in 1888 and has been in continuous service since that time.

Screw pumps corresponding very closely (excepting as to the "balancing" feature) to the design shown as Fig. 1 in the article referred to were designed by the writer in 1893 for the Mississippi River Commission's dredge boat "Alpha"; one of the pumps being built for a head of 30 ft., against which it operated very successfully.

In 1899, the writer designed a vertical shaft pump of this class, which was installed under the direction of Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., at the plant of the Racine Water Co., Racine, Wis. This pump was used for raising the water in the suction well a height of 26 ft., thereby increasing the capacity of the intake pipe from the lake. The pump was driven by a steam engine, by means of a quarter twist belt.

It seems to be well established that installations of this general class, either of "screw," "centrifugal," or a combination of both types, are well adapted for deep-well pumping, and far more efficient than the air lift system.

Yours truly,

Irving H. Reynolds.

Youngstown, Ohio, July 20, 1907.

A Question as to Justifiable Expenditure in Revising a Location.

Sir: Thinking that possibly some of the readers of your valued paper might be interested in a railway location problem which has arisen on an important standard-gage road in Mexico, sufficiently to prove or disprove my figures in regard to saving in operating expenses and advisability of making a change in line requiring some heavy grading and bridge work, please find below the principal conditions for estimating saving in operating expenses, etc.:

Length of division, 34 miles; cost of train mile, $1.00; number of trains each way per day, ten; weight of engines, 100 long tons; weight of train exclusive of engine, 200 long tons.

The proposed change of line will reduce an actual distance of 4.4 miles to 2.4 miles. The total curvature will be reduced from 1,160° to 125°, 1,035° being removed. The number of curves is reduced from 25 to 3. As to rise and fall, there is on the present line a total rise of 348 ft. in direction of higher division point (north) and a fall of 118 ft. On the proposed line there is a total rise of 230 ft. north, with no fall. The proposed change will reduce the ruling gradient from 3.51% to 3.01% going north and remove an adverse grade of 2.9% going south (on this division there is, however, one other adverse grade of 2.4% going south). The minimum radius of curves is to be increased from 325 ft. to 750 ft.; the average radii are 420 ft. and 1,500 ft. on old and new lines, respectively. The gradients referred to above are too long to count upon velocity to assist appreciably.

The interesting question is, what amount of capital could be justifiably spent in making this change, with interest charge fixed at 7%. Maintenance-of-way expense and increased safety of line to be neglected. The cost of the proposed change is estimated at $350,000.

Yours truly,

T. A. Corry,

Supt. Permanent Way, Ferrocarril, Mexicano.

City of Mexico, Mex., July 22, 1907.

Use of Hand-Mixed Concrete and Round Rods in Reinforced Concrete Building Construction.

Sir: In reading over the accounts in the newspapers and engineering journals of the failure of Bridgman Bros. building in Philadelphia the writer was most forcibly struck by two features in the construction of this work: (1) The concrete was hand-mixed; (2) plain round rods were used in the construction, without hooks or other device for securing their ends. Many specifications drawn up by engineers and architects make provision for the use of hand-mixed concrete in reinforced concrete work. It seems to the writer that any engineer or architect who would allow hand-mixed concrete to go into structural features of a building is shamefully ignorant or culpably negligent. Any engineer who has stood on a mixing platform day after day and watched concrete mixed by hand will understand what I mean. It is an absolute impossibility to get results anything like those necessary to safe construction when mixing concrete by hand, and it is the writer's opinion that the time is fully ripe for either absolutely prohibiting the use of hand-mixed concrete in reinforced concrete or else limiting the unit stresses which come upon it to not more

than one half of what could be allowed on machine-mixed material.

It is possible, of course, to get good concrete mixed by hand, but it is highly improbable that 2,000 cu. yds. of concrete can be mixed by hand without getting a considerable proportion of bad concrete in the entire amount, and one batch may be sufficient to let the building drop. Especially is this true in hot weather, when it is absolutely imperative that the concrete be placed without the least possible delay. Even with the quickest work compatible with good machine-mixing it is very difficult to do the best class of work in a blazing summer sun when the materials are heated probably to 150° F. as they frequently are. How much more difficult is it to get anything like good concrete then with the slow method of hand mixing.

As regards the use of round rods, it occurs to the writer that the slight saving in cost effected by the use of round rods over the use of rods giving an effective mechanical bond is a very high price to pay for the risk and uncertainty which is dependent upon their use. There are so many roads on the market to-day which offer an efficient mechanical bond, and the difference in price between these rods and the plain rods is so slight, that the writer fails to see any excuse for the use of plain round rods in beam-work. While it is true that most of the rods having a mechanical bond are patented, yet the royalty on them is so small that nothing but pure bull-headed obstinacy on the part of certain engineers prevents their universal use.

I think the time has come to insist upon these two important features in concrete construction: (1) That all concrete must be mixed in a batch machine; (2) that the bars be of such design as to be practically independent of the adhesion (?) of the concrete to the steel. Those of us who have had the opportunity to tear out concrete which is less than six months old will be able to appreciate how little the adhesion of the concrete to the steel really amounts to at this age.

Yours truly, C. H. Marquess.

1530 Candler Bldg., Atlanta, Ga., July 24, 1907.

FAILURE OF MASONRY ARCH CARRYING ERIE CANAL OVER ONONDAGA CREEK, SYRACUSE, N. Y.

A masonry arch which carried the Erie Canal over Onondaga Creek, at Syracuse, N. Y., collapsed on July 30, and the water from the five-mile level at that point, rushing through the opening, drew five loaded canal boats into the hole and undermined the side walls of an abutting flour mill. The boats and cargo were completely destroyed and the damage to the canal bottom was so great that it will be at least a month before the debris can be cleared away, a new arch erected and the canal reopened. Meanwhile the through traffic of the canal across the state is shut down in one of its busiest seasons.

Onondaga Creek is a small stream passing through the city of Syracuse on its way to Oneida Lake, some two miles distant from the center of the city. Where its line crosses the canal it is about 30 ft. wide and a few feet in depth. The canal at this point was originally about 30 ft. wide, but in 1840 it was widened to 75 ft. and the crossing at Onondaga Creek made by means of three masonry arches instead of the one that had existed up to that time. The most easterly of these arches has since been partially filled up, so that most of the flow of the creek now passes through the other two. The original design of these arches has been lost, but Figs. 2 to 4 are taken partly from a sketch made after the erection of the arches and partly from notes taken on the site after the break of July 30 occurred.

Both sides of the canal are lined with mills and warehouses. On the south bank, at the creek crossing, there is a flour mill bridging the creek, with its north wall on the canal bank. At one time some of the stone pillars supporting the columns of the mill were in the bed of the creek, but a few years ago these pillars were removed and the construction shown in Figs 2 and 3 substituted.

There is some doubt as to the foundations of the piers and abutments of the arches. Naturally, there is no one available who remembers the construction of nearly seventy years ago, no drawings are in existence, and no excavation has ever been carried on below the bed of the creek. It was supposed that there was a pile foundation, as similar work thereabouts has been so constructed, but in that portion of the abutment washed out by the flood following the accident there are no signs of any such footing. As far as it can be determined, then, the foundations start at or very near the bed of the creek; about 8 ft. above the creek bed the arches are sprung, each with a rise of 6.6 ft. and a span of 25.3 ft., with two intermediate piers, each 12.6 ft. wide. On top of the arches is an earth fill of 2½ ft. to the bottom of the canal, which normally holds

FIG. 1. BREAK IN ERIE CANAL AT SYRACUSE, N. Y.

(The canal at this point crosses Onondaga Creek over three masonry arches, built in 1840. One of these arches collapsed on July 30, letting the five-mile level into the creek and wrecking five boats.)

9 ft. of water. The canal wall and the mill wall each rested on or very near the arch extrados. As this portion has been entirely swept away it is difficult to determine the exact elevation of the footings of these walls. Relative elevations of those portions of the walls left standing, however, show that the bottom of the walls and the extrados of the arch at its crown could not have been separated by more than a few inches. Similarly two of the supporting pillars were over the arch, but so near its haunch that there is several feet of dirt fill between the two. The main back portion of the mill building was carried over the creek on steel trusses, running from walls in line with the piers and abutments of the arch. There was no machinery working at the part of building bearing upon the arches, that

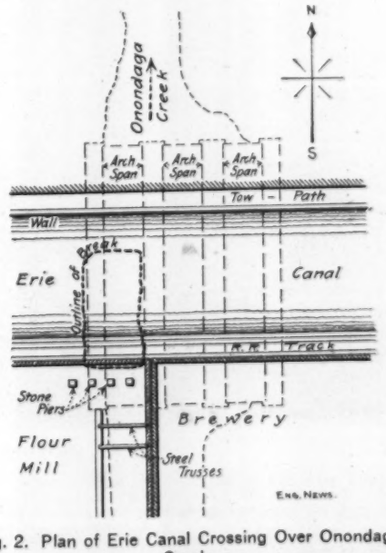

Fig. 2. Plan of Erie Canal Crossing Over Onondaga Creek.

space being almost entirely used for storage. In the dirt-filled space between the canal and mill walls a single-track standard gage railway ran.

The arches are constructed of a grey limestone, locally known as Onondago bluestone, of a fine, hard texture, not unlike the Hudson River trap. They are laid up in a single line of voussoirs about 1 ft. thick and ranging from 2½ ft. deep at haunch to about 2¼ ft. at crown. They are well cut and shaped to fit, and although apparently laid in lime mortar, time has removed most of such binding.

The break was first noticed by an unusual current, which swept two canal boats, moored on the south bank of the canal just east of the flour mill, away from their moorings toward the west arch. There is some doubt as to just where on this arch the break started, but as these first boats were dragged toward the middle of the canal it is probable that it was there that the water first went through. Two boats were drawn into the opening and smashed. By this time the rushing waters had undermined the mill walls, which fell on the two boats, and more completely wrecked them. Three other canal boats were drawn by the heavy current and wrecked upon the first boats and the stone and brick debris from the walls. The bottom of the canal was washed out on a slope from the bottom of the creek to a point some 200 ft. west of the arches. The two arches standing prevented the washing of the canal bottom to the east. Fortunately all persons on the boats and in the mill were rescued and the primary loss included only the destroyed property and three horses that were drowned. The final area of the collapsed portion of the arch is shown in Fig. 2.

The cause of the failure is largely a matter of conjecture. Two theories have been offered. For one, it is claimed by many residents thereabout that the roof of the failed arch has been leaking for some time, and that on the morning of the accident a stream of water as large as a man's arm came through the arch ring at about the supposed point of failure. Such a leak, long continued, would necessarily have weakened the arch ring by leaving a passageway through which water from the canal could reach the extrados of the arch and from there find its way down back of the abutment, there to undermine the masonry to a point of final failure. As evidence of a greater flow of water from the canal down back of the abutment, such a leak might be an indication of the manner of failure, but

a single leak through the barrel of a masonry arch, of material as compact and construction so solid as this, can hardly be considered of sufficient individual importance to cause failure. If the action of the seeping water had so far accomplished the deterioration of the arch ring stone as to make it incapable of bearing the thrust, the leakage must have been so far advanced as to make its presence known and its prevention a matter of obvious precaution on the part of the engineers in charge of the canal. However, the state engineers deny the existence

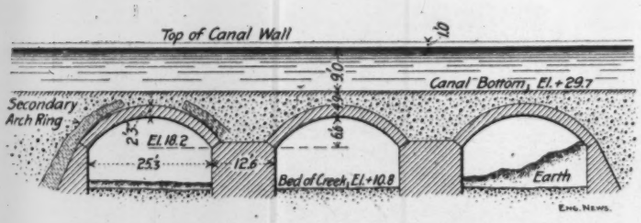

FIG. 3. TRANSVERSE SECTION THROUGH ARCHES.

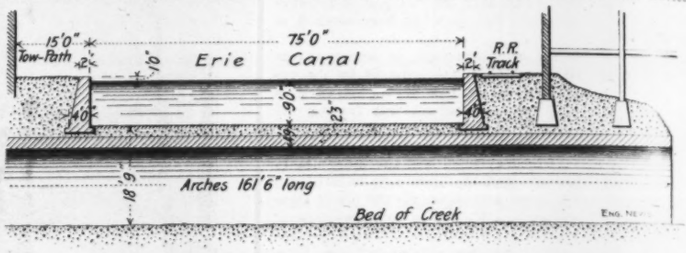

FIG. 4. TRANSVERSE SECTION THROUGH CANAL.

of any leak large enough to warrant suspicion. Rather do they think that the creek washed under the west abutment and undermined it. No piles can be found under this abutment, although the earth has been washed to a depth of several feet below the footings. The bed of the creek is also the natural earth, so that it was quite possible for the stream to work under the abutment, the destruction of which would have been helped by the heavy pressure of an 8-ft. fill and 10-ft. surcharge working against the arch thrust.

Figs. 1 and 5 show the canal just after the last boat had been carried into the break. The stone wall across which the boat on the right is lying is the remains of some work at this point before the widening of 1840. Its top was about at the elevation of the canal bottom. No one around the work at the present time knows just what the wall was for, and no drawings can be found showing it. The extent of the washing out of the bottom can be well realized by noting that the lowest part of this wall shown in the view is some 10 ft. below the canal bottom.

The break in the arch at the north end (Fig. 6), where failure probably first occurred, is jagged, following the line of the stones. Large cracks show back from the break for several feet. In contrast to this, the south break is clean, following a straight line through stone and joint, many of the stones being sheared off through their body. It is quite probable that this sharp break is due to the fall of the mill wall at this point, which gave way after a large portion of the arch had gone out. A heavy brick wall falling on a cantilevered arch ring would be extremely liable to break the stones of the ring in a sharp line, regardless of joints. At the south break the rushing water and earth would exert an evenly distributed pressure which would tend to tear out the separate stones rather than break through the voussoirs. A secondary ring of arch stones has been built over both the haunches of the northern part of the west arch, as shown in Figs. 3 and 6. This secondary ring consists of small stones placed in some semblance of voussoirs, but very evidently not at the same time nor with such care as the original arch ring. Whether they were put in place in order to centralize the arch pressure line or to cover up a leak is a matter of doubt. They do not show on the southern face of the break under the mill walls.

The authorities have a large force of men working upon the wreck, clearing away the debris and preparing the site for the erection of a concrete arch in place of the wrecked portion of the old arch. This concrete arch will be only a temporary expedient, for it is expected that a large part of the masonry now standing has been so damaged as to require its removal. However, the work will be strong enough to carry traffic until the shut-down of next winter's season.

THE NEW YORK BARGE CANAL CONTRACT held by the Ferguson Contracting Co., which was suspended on July 25, 1907, because very inadequate progress had been made, as noted in our last issue is again in the hands of the contractor, as described in the following statement which we have obtained:

The work on Barge Canal Contract No. 2, which was suspended by F. C. Stevens, Superintendent of Public Works, at the direction of the Canal Board, on July 25, has been permitted to be resumed by the contractor, the Ferguson Contracting Co., of 69 Wall St., New York City. The work is located at Waterford, and the contract price is $852,330. The contract was executed on April 3, 1905, and is to be completed October 15, 1908. It was found that the supply of material on the work and the arrangement of the plant and machinery were totally inadequate for the proper progress of the work and for its completion within the contract time, and that the rate of progress was so slow that the work would not be completed for many months beyond the date fixed by the contract. The order of the Superintendent of Public Works, of July 25, suspending the work, was issued by authority of a resolution passed by the Canal Board which directed him to suspend the work and to take such steps as he should find necessary in order that the work should be completed within the time fixed. Under the law and the contract, the Canal Board has power to suspend the work on any contract upon the certificate of the State Engineer that it is not progressing in a satisfactory manner, and may order the work to be continued under the direction of the Superintendent of Public Works, the cost thereof to be charged against the contractor and his surety; or it may cancel the contract and have it readvertised and re-awarded. After due inquiry, Superintendent Stevens ascertained that there was no good excuse for the deficiency in plant on the work, since the contractor is financially both responsible and resourceful, its financial standing being of the best. After accurately determining the rate of progress which must be reached and maintained in order to complete the contract by Oct. 15, 1908, and also determining the additions to the operating plant which would be necessary in order to reach such rate of progress, the Superintendent of Public Works secured the contractor's promise to furnish such additions and maintain a fixed rate of progress. The contractor's surety also joined in the contractor's request to be allowed to resume. This solution of the problem being satisfactory to the State Engineer, Superintendent Stevens on July 31 authorized the contractor to resume the work.

NOTICES TO CEASE POLLUTING THE RARITAN River prior to July 1, 1911, are to be served by the State Sewerage Commission of New Jersey upon the Towns of Raritan and Somerville, the Borough of Bound Brook, and upon Hugh C. Pierce. The Township of Piscataway has also been ordered to cease polluting the Raritan River and its tributaries, this order to take effect July 1, 1908. Mr. Boyd MacLean is Secretary of the Commission, and has been formally instructed to serve the notices.

PUBLIC IMPROVEMENTS FOR THE BOSTON Metropolitan District are to be investigated in a very comprehensive manner, under an act of the Massachusetts Legislature approved June 15, 1907. The act, which may well be considered as a model of its kind, is sufficiently brief to warrant publishing it in full, as follows:

Resolved, That the governor, by and with the advice and consent of the council, shall appoint three persons, and the mayor of the city of Boston shall appoint two persons, who shall together constitute a commission of five for the purposes hereinafter named. The chairman of said commission shall be designated by the governor. The said appointees shall serve without compensation, and shall be persons of recognized qualifications and large experience in respect to one or more of the following subjects or professions, namely: finance, commerce, industry, transportation, real estate, architecture, engineering, civic administration and law. Said commission shall investigate and report as to the advisability of any public works in the metropolitan district which in its opinion will tend to the convenience of the people, the development of local business, the beautifying of the district, or the improvement of the same as a place of residence. It shall consider the establishment of a systematic method of internal communication by highways, the control or direction of traffic and transportation, and the location of such docks and terminals as the interests of the district may demand. It shall recommend the method of executing and paying for such improvements as it may suggest, and shall make such maps, plans and estimates of cost as may be needed for its investigation, or for the proper presentation of its conclusions, and may employ such assistants therefor as it deems necessary. The commission may expend such sums of money, not exceeding $25,000, for clerical, expert and other assistance, and for other incidental expenses, as it deems necessary. The commission shall make its final report to the governor and to the mayor of Boston on or before the 1st day of December, 1908, and its powers and duties shall then terminate. The governor shall transmit the report to the general court of the year 1909. The expenses incurred under the provisions of this act shall be assessed upon the metropolitan parks district.

The Commissioners appointed, with the professional or other interests which they represent, are as follows: Law, Mr. Benjamin N. Johnson, of Johnson, Clapp & Underwood, Boston, Mass.; Architecture, Mr. Robert S. Peabody, of Peabody & Stearns, Boston, Mass.; Finance, Mr.

FIG. 5. ANOTHER VIEW OF THE BREAK.

Henry B. Day, of R. L. Day & Co., Boston, Mass.; Transportation, Mr. Thomas J. Gargan, Rapid Transit Commission, Boston, Mass.; Engineering, Mr. Desmond FitzGerald, M. Am. Soc. C. E., Brookline, Mass. Mr. Johnson is Chairman of the Commission.

THE LARGEST RAFT towed to New York since the big Leary raft was brought here from St. Johns, N. B., 16 years ago, arrived on Aug. 5, after a trip of twelve days from Nova Scotia. It consisted of 6,000 spruce piles, and was 320 ft. long, 40 ft. wide amidships, 25 ft. wide at each end, and drew 12 ft. of water.

THE TRANSMUTATION OF COPPER INTO LITHIUM, by means of radium emanations, has just been announced by Sir William Ramsay, before the British Association for the Advancement of Science.

PANAMA CANAL WORK DURING July is summarized in a cable from Chief Engineer Goethals thus: Excavation at Culebra, 770,570 cu. yds.; excavation at Gatun, 74,765 cu. yds.; dredging in canal, 212,710 cu. yds. The rainfall during the month was 9½ ins., as against 14 ins. in the preceding month, June. The increased excavation permitted by the drier weather makes the July work the largest month's work yet done on the canal. The totals above given, with 731 cu. yds. excavated at Mindi, make an aggregate of excavation of 1,058,776 cu. yds., which is almost 50% more than the June excavation. The Culebra excavation alone was 150,000 cu. yds. more in July than in June, and this difference is just about equal to the entire excavation at Culebra done in July, 1906.

THE "GEORGIA" TURRET DISASTER of July 10 has been investigated by the Board appointed for the purpose, and the findings were passed upon on Aug. 1 by Acting Secretary of the Navy T. H. Newberry. In brief, the gist of the report is that a "flareback" ignited one of the two bags of powder about to be placed in the gun which had just been fired. The point of engineering interest in the unfortunate occurrence is that the testimony of those in the handling room showed that burning grains of powder fell through the openings in the "shutter" between it and the turret, through which pass the lines of the ammunition hoist. It seems that burning grains fell into both the 8-in. handling room and the 12-in. handling room below it; there was powder exposed in the 8-in. room, ready to go up, and only quick work prevented its ignition. The relative arrangement of handling rooms and turrets in American battleships is peculiar to our navy, and this accident has shown that more adequate means of isolation must be adopted to forestall greater disasters than this one.

FOUR WERE KILLED and 25 injured on Aug. 6 in the wreck of the Titusville Express on the Pennsylvania R. R., at Kelly, Pa., 35 miles from Pittsburg. A gondola loaded with coal broke from a freight train and ran down a switch on to the main track; the express, running at 60 miles an hour, came around a curve and struck it before speed could be reduced, and the engine, tender, baggage and express cars, and three day coaches were derailed and overturned.

AN ATTEMPT TO WRECK THE PITTSBURG FLIER on the Erie R. R. was made on the night of Aug. 5, between Hiram and Garrettsville, Ohio. The trunk of a tree had been dragged to the track and chained across it, but was discovered in time by section men.

A BRIDGE FAILURE caused a railway wreck at Angers, France, on Aug. 4, according to press reports. A passenger car fell with the bridge, killing some 25 persons.

A LOCOMOTIVE BLEW UP in the Pennsylvania R. R. yards at Urbana, Ohio, on Aug. 1. Three men were killed.

A BURLINGTON FREIGHT LOCOMOTIVE, drawing a train near Breckenridge, Mo., exploded on Aug. 1, killing three men and fatally injuring the engineer.

A LOCOMOTIVE BLEW UP at Milan, Tenn., on July 30, while drawing a fast Illinois Central fruit train. The train was wrecked, running at a high speed, and another freight train, standing on a siding, was also wrecked. Four persons were instantly killed, one fatally injured and ten seriously so. Both trains caught fire and were destroyed.

IN A REAR-END COLLISION on the Missouri Pacific Ry. near Atchison, Kansas, between two freight trains, four men kere killed and two injured. Train No. 164 ran away down Shannon Hill and struck No. 154, standing on the main track.

AN OPEN SWITCH on the Baltimore & Ohio R. R. at McKeesport, Pa., ran an accommodation train into a freight on July 31, killing two and injuring five persons. Misunderstanding of orders by employees is the reported cause.

COLLISION OF AN EMPTY PASSENGER TRAIN with a freight train on the New York, New Haven & Hartford R. R. at Campello, Mass., on July 29, killed four trainmen and injured three. The locomotive of the freight had failed, and the train was standing on the express track when the passenger train crashed into the caboose from the rear, telescoping it. The freight train had gone but 20 miles further after the wreck when another train hit it from the rear and caused the serious injury of one more employee.

DERAILMENT of a northbound train on the Atchison, Topeka & Santa Fe Ry., near Red Rock, Okla., is reported to have killed one and injured many more persons on Aug. 1.

A HEAD-ON COLLISION between a freight and a passenger car, on the Norwich & Westerly Electric Ry. near North Stonington, Conn., killed one and injured ten persons on Aug. 1. The wreck occurred on a curve, and both cars were running at high speed. According to road officials, responsibility rests on the crew of the passenger car who disregarded orders to wait on a siding for the freight car.

TWO HEAVY INTERURBAN ELECTRIC CARS collided head-on on Sunday, July 28, near Toledo, Ohio, injuring eight persons. The cars were running on the single track of the Maumee Valley electric line, on which a block system of electric signals is installed. It is said that one of the crews ignored a signal set against them and attempted to run a switch.

IN A REAR-END COLLISION on the New York, New Haven & Hartford R. R., on July 29, between a passenger train and a "mogul" engine running light, one person was killed and several were injured, near Danbury, Conn. It is said that the light engine had broken down; the lantern of the man sent back to flag approaching trains was extinguished, and before he could relight it the passenger train came along at 40 miles an hour.

BLASTS IGNITED ACCUMULATED GAS in the 30-ft. shaft of the East Side Pennsylvania R. R. tunnel at Thirty-third St. and Park Ave., New York City, on July 23. One man was killed and three injured.

AN EXPLOSION in one of the mills of the American Powder Co. near Avoca, Pa., blew up the entire plant on Aug. 1. Resulting fire completed the work of the explosion. The superintendent of the plant was fatally injured. The mill manufactured smokeless powder.

SUCCESSFUL EXPERIMENTS IN PHOTO-TELEgraphy over the 320 miles from Munich to Berlin were carried out on July 31 by Prof. Stern, who has been developing the invention. Photographs were clearly transmitted over a direct wire loaned by the Government.

CONSTRUCTION AND OPERATION OF TURRETS on battleships will be investigated by a board of naval officers appointed by Acting Secretary Newberry, of the Navy, on July 31, with a view to recommending precautions to prevent such accidents as that which recently occurred on the "Georgia." Lieutenant Commanders L. A. Kaiser and Carl T. Vogelsang, and Lieut. L. C. Palmer compose the board.

A GENERAL EXHIBITION OF INVENTIONS for use in the minor industries is in progress in Berlin, at the exhibition building in the zoological gardens. It opened on June 15, and will continue until Sept. 15. It is held as a preliminary to a larger exhibition to be held later in Berlin, and for the purpose of stimulating invention and "enlarging and multiplying the points of contact between inventor and capitalist, designer and manufacturer, producer and customer."

THE SANITARY PROTECTION OF THE BRONX River and the creation of a Bronx River reserve and parkway are provided for by an act of the New York Legislature recently approved by Governor Hughes. Land will be taken along the river from the present Bronx Park in the city of New York to and into Westchester County, including areas in the cities of Yonkers and Mount Vernon and in the townships of Eastchester, Greenburgh, Scarsdale, White Plains, Mount Pleasant and North Castle. The cost of the land will be borne by the city of New York and by the county of Westchester.

SHALLOW WELLS IN THE DISTRICT OF COLUMbia were ordered closed on May 21, 1907, by the District Commissioners, as a possible aid in cutting down the excessive typhoid mortality at Washington. Protests against this action having been received and considered, the Commissioners on July 8 excepted from their order 8 of the 63 wells, on the ground that there were no water mains within convenient reach of the people making use of the wells. It is understood, however, that in case of positive proof of pollution, any or all of these wells will be closed. Statements regarding the use of shallow public wells in Washington were published in our issues of Nov. 8, 1906, and July 11, 1907, in connection with the reports by Messrs. Horton and Sedgwick and the report by the U. S. Public Health and Marine-Hospital Service, on the prevalence and cause of typhoid fever in the District of Columbia.

THE ELECTRIFICATION OF THE TEXAS-MIDLAND R. R. has been determined upon, a correspondent writes. The investigations on which this decision was based

FIG. 6. ARCH BREAK AT NORTH SIDE OF CANAL.
(Note secondary arch ring at haunches.)

have been under way for about two years. The cost of change on the entire line of 120 miles is placed at about a million dollars.

THE SPREAD OF INFECTIOUS DISEASES BY FLIES is a subject proposed for investigation by the Committee on the Pollution of State Waters of the Merchants' Association of New York. A circular issued by the Association contains the following statement:

The Association's Committee on Pollution of State Waters, as a result of its study of the pollution of the waters surrounding New York and the effect upon the health of the city, has been led to the conclusion that an investigation of the part played by flies in carrying germs of intestinal diseases from the polluted waters to the food supplies exposed in the city, would be well worth undertaking. The Committee feel that such an investigation might possibly result in the disclosure of knowledge which could be made of vast benefit in checking intestinal diseases in the city, thereby preserving the health of the community, particularly during the summer season.

The Executive Committee of the Merchants' Association, in its circular, states that, while it approves the recommendation, it does not feel that it can appropriate the funds necessary for the study from its treasury; but it suggests that at least 100 members contribute $10 each for the purpose of investigation, and that checks to that end be sent to the Association at 66 Lafayette St., New York City. The circular gives no details of the character of the proposed investigation.

PERSONALS.

Mr. Wm. Graham, an Assistant Chief Engineer of the Baltimore & Ohio R. R., has resigned to go with the New York, New Haven & Hartford R. R.

Mr. Francis J. McNulty has tendered his resignation as Assistant to the Chief Engineer of the Wilmington, Del., water department, to take effect on September 1.

Mr. V. R. Hughes, Chief Engineer of the Pueblo & Suburban Traction & Light Co., recently resigned to take the same position with the Northern Colorado Power Co.

Mr. B. M. Laughead, Resident Engineer on the Blue Ridge division of the South & Western Ry., was married on July 24 to Miss Elsie M. Jackson, of Waynesville, N. C.

Mr. Olin E. Emens, of Seneca Falls, N. Y., has been appointed Superintendent of Repairs of the Cayuga & Seneca Canal, in the vacancy made by the resignation of Mr. Geo. Clark.

Mr. T. B. Burnite has been appointed Superintendent of the works of the John A. Traylor Machinery Co., of Denver. He has been connected with their engineering and sales department.

Mr. J. E. Kirkham, Assoc. M. Am. Soc. C. E., at present Designing Engineer with the American Bridge Co., has been appointed Associate Professor of Civil Engineering at Iowa State College, Ames, Ia.

Dr. Hermann von Schrenk, whose resignation as Pathologist in the U. S. Department of Agriculture was noted here on July 11, has been appointed Supervisor of Timber for the St. Louis & San Francisco R. R.

Mr. Samuel H. Lea, M. Am. Soc. C. E., State Engineer of South Dakota, has been appointed Superintending Engineer of the South Dakota State Capitol, now under construction at Pierre. He retains his position as State Engineer.

Mr. Wm. Graham, Assistant Engineer of Bridges and Buildings with the Baltimore & Ohio R. R., has resigned to accept a corresponding position with the New York, New Haven & Hartford R. R. His successor is Mr. W. S. Bouton.

Mr. Geo. W. Wildin, formerly Assistant Superintendent of Motive Power for the Lehigh Valley R. R., was recently appointed Mechanical Superintendent of the New York, New Haven & Hartford R. R., succeeding Mr. F. T. Hyndman.

Mr. Wm. D. Ennis, M. Am. Soc. M. E., has been appointed Professor of Mechanical Engineering at the Polytechnic Institute of Brooklyn. He has been engaged for the past two years in special power work with the American Locomotive Co., at Schenectady, N. Y.

Mr. W. C. Orem, General Manager of the Utah Apex Mining Co., at Bingham Canon, has resigned that position. He will devote his entire attention to the management of the Douglas Copper Co. at Yerington, Nev., with which he has been connected for some time.

Mr. Simon B. Storer, Assoc. M. Am. Inst. E. E., formerly with the Niagara, Lockport & Ontario Power Co., has opened an office at 732 University Block, Syracuse, N. Y., for consulting practice. He will specialize in power transmission, power contracts, and commercial investigations and reports.

Mr. Wm. Seibert, former Division Superintendent of the surface lines of the Brooklyn Rapid Transit Co. converging at Ridgewood, was on July 29 appointed Superintendent of all surface lines of the system. In 1885 Mr. Seibert began his street-railway career as conductor on a Nostrand Ave. horse-car.

Major Harry F. Hodges, Corps of Engineers, U. S. A., M. Am. Soc. C. E., took charge of the Washington office of the Panama Canal Commission on Aug. 1, in accordance with the President's recent order materially reducing the Washington force. Major Hodges has for a long time been Assistant to the Chief of Engineers.

Prof. James M. White, succeeded as Dean of the College of Engineering at the University of Illinois by Prof. W. F. M. Goss, formerly Dean at Purdue University, will continue his connection with the University, dividing his time between his new position as Supervising Architect for the University and his instructional work as Professor of Architectural Engineering.

Mr. Herbert C. Hale, M. Am. Soc. M. E., Superintendent and General Manager of the Mineral Ridge Mfg. Co., of Mineral Ridge, O., and Mr. F. B. Duncan, Manager of the Akron Electrical Mfg. Co. of Akron, O., have resigned their positions and become associated under the firm name of Hale & Duncan, as contracting and designing engineers. They will specialize in the electrical equipment of mines.

Mr. Frederick E. Leefe, U. S. Junior Engineer, has been placed in local charge of the reconstruction of the Springdale Dam, Springdale, Pa. This dam was blown up last winter under the direction of Major Wm. L. Sibert, Corps of Engineers, U. S. A., to save valuable property on the abutment side of the river; this was noted in Engineering News for Jan. 24, 1907, p. 115. Mr. Leefe was formerly in charge of the construction of Dam No. 2 on the Allegheny River at Aspinwall, Pa.

Messrs. A. W. Dow and F. P. Smith have formed a partnership as the firm of Dow & Smith, with offices at 120 E. 23d St., New York City; they will specialize in asphalt paving for municipalities, and will act as consulting engineers on road surfaces of all kinds, waterproofing reservoirs, etc. Both are graduates of the School of Mines of Columbia University; Mr. Dow was formerly Inspector of Asphalts and Cement for the city of Washington, D. C.; Mr. Smith has been chemist and asphalt expert for the Alcatraz Co., the Union Oil Co., of California, the British Paving Co., Ltd., and the A. L. Barber Asphalt Co., as well as Chemist to the U. S. Navy Department for a number of years.

Obituary.

Samuel McClintock Hamill, an officer of the General Electric Co., in its lighting department, died at Schenectady on July 29 at the age of 49. He was formerly Manager of the Brush Electric Co., of Cleveland, before it was merged with the General Electric Co.

John C. Henderson, Assistant to the President of the Louisville & Southern Indiana Traction Co. and associated companies, died at his home in New Albany, Ind., on July 23, at the age of 63. He went to New Albany three years ago as Chief Engineer in the construction of approaches to the Big Four bridge at Jeffersonville, Ind., built for the use of interurban trains crossing between there and Louisville. He was appointed to his late position two years ago.

John T. Jones, of Wilkinsburg, Pa., General Superintendent of Operation of the United Coal Co., was killed on July 30 by a fall of slate in the entrance to Edna mine No. 1, near Irwin, Pa. Mr. Jones was for a number of years General Superintendent of the mines of the Monongahela River Coal & Coke Co. He was 62 years old. Joseph Graham, fire boss at the Edna mine, was killed with him, and three other officials of the company had a narrow escape.

Brig. Gen. Charles Francis Powell, U. S. A., retired, died at his brother's home in St. Paul on July 30, at the age of 64. He was born in Jacksonville, Ill., and after gallant service in the Civil War was appointed to the U. S. Military Academy, where he graduated in 1867 with a standing that put him in the Corps of Engineers. After graduation he served for a time in the Battalion of Engineers, engaging in numerous geodetic and topographical surveys. Later he was Engineer in Charge on the Cascades Canal of the Columbia River, and superintended the construction of the jetty at the mouth of that river. His most recent detail was as engineer of the defenses of Long Island, involving the improvement of several of its harbors. He rose to the rank of colonel, and was retired in March, 1906, with the rank of brigadier general.

ENGINEERING SOCIETIES.

COMING MEETINGS.

CANADIAN INSTITUTE OF ARCHITECTS.
Aug. 19-23. First annual meeting at Montreal. Secy., Alcide Chaussé, P. O. Box 259, Montreal.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, Oswego, N. Y.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 10-13. Thirty-eighth annual convention at St. Paul, Minn. Secy., A. P. Dane, Reading, Mass.

NATIONAL IRRIGATION CONGRESS.
Sept. 23-28. Fifteenth annual convention at Sacramento, Cal.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 8. Annual meeting at Washington, D. C. Secy., Edw. A. Moseley, Interstate Commerce Commission, Washington, D. C.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 14-18. Annual convention of this and affiliated associations at Atlantic City, N. J. Secy., Bernard V. Swenson, 29 West 39th St., New York City.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION.
Oct. 14-16. Annual convention at Atlantic City, N. J. (See preceding item.) Secy., S. W. Mower, Southwestern Traction Co., London, Ont.

VERMONT ELECTRICAL ASSOCIATION.—The sixth annual meeting will be held at St. Albans, Vt., Sept. 18 and 19. Mr. F. H. Foote of the Executive Committee, at St. Albans, is in charge of local arrangements. The first day will be devoted to outing and games and a shore dinner. On the morning of the second day a trip will be taken to the plant of the Vermont Power & Mfg. Co. at Fairfax Falls. This excursion will be followed by a business session, and several papers are to be read.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—The following queries will come up for discussion at the convention in St. Paul: (1) Have you found any material or coating that will resist the action of rust? (2) Denatured alcohol—is it a satisfactory substitute for pure grain alcohol for railroad painters' use? (3) Is it advisable to apply three coats of body color to a car if two coats will cover? (4) Can the lasting qualities of light freight-car stencil paints be improved? (5) From a painter's standpoint is pressed fiber as durable as a 3-ply wood veneer headlining for passenger equipment? (6) What should be the nature of a detergent for railway paint-shop use?

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.—The summer meeting, on Aug. 14, will be devoted to the inspection of engineering work in the Naugatuck Valley. A special electric car will convey the members from New Haven to Waterbury via Derby, allowing inspection of the new work on the electric road and the work in progress in connection with the double-tracking of the Naugatuck Division of the New York, New Haven & Hartford R. R. At Waterbury, the Sewage Experiment Station of the city will be visited and also the railroad work in the abolishment of all grade crossings. The afternoon will be devoted to a baseball game followed by a dinner. Mr. J. Frederick Jackson, of New Haven, is Secretary.

CANADIAN INSTITUTE OF ARCHITECTS.—A provisional or temporary Board of Organization has been formed, involving the following provisional officers: President, A. F. Dunlop, Montreal; Vice-Presidents, Edmund Burke, Toronto, Maurice Perrault, Montreal, and S. Frank Peters, Winnipeg; Secretary, Alcide Chaussé, Montreal; Treasurer, J. W. H. Watts, Ottawa. The Provisional Council, together with the officers named, is composed of architects from every province of Canada, and from every existing architectural club in Canada—of which clubs the Institute is, in a sense, a consolidation.

At the coming meeting, in Montreal, which will be held in the Assembly Hall of the Canadian Society of Civil Engineers, the following matters will be taken up in order: (a) Organization and incorporation; (b) representation of architectural interests in the Royal Canadian Academy; (c) discussion of uniformity of building laws; (d) public architectural competitions; (e) duty on plans from foreign architects.

AMERICAN INSTITUTE OF MINING ENGINEERS.—With a large attendance of delegates, the summer meeting was opened at the King Edward Hotel, Toronto, Ont., on July 23. In the absence of the Mayor, Alderman J. J. Graham welcomed the delegates, President John Hays Hammond responding. Dr. R. W. Raymond, Secretary, was presented with an oil portrait of himself in recognition of his work in the interest of the Institute. It was announced that honorary membership would be conferred upon Dr. Chas. D. Walcott, late Director of the U. S. Geological Survey and now Secretary of the Smithsonian Institution, in recognition of his contributions to the science of geology and of his cordial and effective cooperation with the Institute. At the session on July 23, Dr. Jas. Douglas, of New York City, presented "Some Reflections on Secrecy in the Arts;" Mr. E. W. Parker, of Washington, D. C., "Coal Briquetting in the United States;" Prof. W. P. Blake, Arizona School of Mines, "Destruction of the Salt Industry at Salton, San Diego, Cal., by the Overflow of the Colorado River." At the session on July 24 "The Electric Air Drill" was presented by Mr. Wm. L. Saunders, of New York City; "Tar Sands of Athabaska," by Dr. Robert Bell, of Ottawa, Ont.; "The Cobalt Mineral Area" (illustrated), by Prof. W. G. Miller, of Toronto, Provincial Geologist of Ontario; and "The Sudbury Mineral Area" (illustrated); by Mr. Alfred E. Barlow, of Ottawa. Wednesday evening a number of delegates, as guests of the Ontario Government, left Toronto on a special train for Cobalt, Haileybury, Temagami, Sudbury, and the Moose Mountain iron range.